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OF

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RHINOLITHS-THERMOTAXIS

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EDITORIAL NOTE

THIS is the penultimate volume of the *Encyclopedia and Dictionary of Medicine and Surgery*, and it carries the subject-matter of the work from *Rhi-* to *The-*, the rubrics running from *Rhinoliths* to *Thermotaxis*. Of articles which did not appear in the *Encyclopædia Medica* two may be specially referred to: that on the MEDICAL EXAMINATION OF SCHOOLS AND SCHOOL CHILDREN, by Dr. Leslie Mackenzie of Leith; and that on the STATUS LYMPHATICUS, by Dr. W. H. Wynn of Birmingham. Recent advances in the knowledge of SYPHILIS have been taken notice of in a contribution dealing with the causal agent of that disease and the serum diagnosis of the malady; and novel aspects of SENSATION are treated in a short paper. In addition to these articles the volume contains more than the usual number of short paragraphs on medical and surgical matters, and of definitions of medical terms, for it includes the whole of the large letter S. The longest article is that on the STOMACH, which is treated in two sections, *Medical* and *Surgical*; another long contribution deals with the SKIN under six subdivisions; and other notable articles are those on SMALLPOX, the SPINAL CORD, SYPHILIS, TABES DORSALIS, and THERAPEUTICS. The volume contains 1588 subject headings, the largest number in any single volume except the second (which contained 1758). The total number of rubrics in the nine volumes is ten thousand seven hundred and eighty-four.

There are sixty-eight articles of more than 1000 words in length; some of these extend to thirty or forty pages. They deal with such a variety of subjects as *Rickets* (by the late Dr. Ashby of Manchester), *Rodent Ulcer*, *Rubella*, *Diseases of the Salivary Glands*, *Scabies*, *Scarlet Fever*, *Schools and School Children*, *Sciatica*, *Sclerema Neonatorum*, *Sclerodermia*, *Diseases of the Sclerotic*, *Diseases of the Scrotum and Testicles*, *Infantile Scurvy and Scurvy in Adults*, *Senile Insanity*, *Sensation*, *Septicæmia*, *Sewage and Drainage*, *Shock*, *Injuries and Diseases of the Shoulder Joint*, *Diseases of the Skin*, *Normal and Morbid Sleep*, *Sleeping Sickness*, *Smallpox*, *Snake-Bites*, *Spasm*, *Spina Bifida*, *Diseases of the Spinal Cord*, *Surgery of the Spine*, *Surgical and Medical Affections of the Spleen*, *Sprue*, *Stammering*, *Status Lymphaticus*, *Sterility*, *Diseases of the Stomach*, *Surgery of the Stomach*, *Strabismus*, *Sunstroke*, *Suppuration*, *Syphilis*, *Teeth*, *Tendon-Jerks*, *Teratology*, *Tetanus*, *Therapeutics*, etc.

Of articles of less than 1000 words but of at least ten lines in length, there are one hundred and seven in this volume. Among the subjects dealt with in these articles of medium length are *Rhubarb*, *Rigidity*, *Rosæ Gallicæ Petala*, *Rupture*, *Saccharin*, *Salicin*, *Salicylic Acid*, *Salol*, *Santonin*, *Sapo*, *Sarcoma*, *Sarsaparilla*, *Scalp*, *Scammony*, *Sclerosis*, *Scoliosis*, *Scopolamine*, *Scotoma*, *Sea Sickness*, *Sea Voyages*, *Seborrhœa*, *Seidlitz Powder*, *Senegæ Radix*, *Senna*, *Serpentariæ Radix*, *Sialogogues*, *Silver*, *Sinus*, *Situs Viscerum Inversus*, *Skull*, *Smell*, *Sodium*, *Souffle*, *Spermatorrhœa*,

Sphenocephalus, *Spinthariscope*, *Squill*, *Staphylococcus*, *Stenosis*, *Stinging Insects and Plants*, *Stovaine*, *Stramonium*, *Streptococci*, *Stria*, *Strophanthus*, *Strychnine*, *Stypticine*, *Styptol*, *Succi*, *Sulphonal*, *Sulphur*, *Sulphuric and Sulphurous Acid*, *Sulphuric Ether*, *Suppository*, *Surgeon*, *Sweating*, *Sycosis*, *Tabaci Folia*, *Tabes*, *Tannic Acid*, *Tar*, *Telegony*, and *Thalamencephalon*.

The remaining 1413 subject headings are mostly of the nature of definitions, short explanatory paragraphs, and cross references; they are very numerous in this volume, for as the *Encyclopedia* nears its end there is more and more necessity for referencing back to previous volumes. A few of the many matters referred to under these 1413 rubrics may be named here in order to give some idea of the range of this part of the work: *Rhinorrhœa*, *Rhombencephalon*, *Rhonchus*, *Rosette Body*, *Rossbach's Disease*, *Row's Test*, *Rubber Gloves*, *Scaphoid*, *Schatz's Method*, *Schenck's Method*, *Schmidt's Test*, *Scillism*, *Sclerodactyly*, *Scolex*, *Screw Worm*, *Segregator*, *Semester*, *Senator's Phlegmon*, *Septic Tank*, *Sewer Gas*, *Skatol*, *Skutsch's Pelvimeter*, *Smoke Test*, *Specialism*, *Spherocephalus*, etc.

In the Editorial Note to the next volume of this work I hope to be able to announce the approximate date of publication of the *Quinquennium of Medicine*, now in active preparation, which is intended to serve as a Supplementary Volume to this Encyclopedia as well as to the *Encyclopædia Medica*.

J. W. BALLANTYNE.

September 5, 1908.

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ENCYCLOPEDIA AND DICTIONARY OF MEDICINE AND SURGERY

Rhinoliths.—Nasal calculi. *See* Nose, Foreign Bodies (*Rhinoliths*).

Rhinophyma.—A form of acne rosacea, with hypertrophy, affecting specially the nose. *See* Acne (*Rosacea*).

Rhinoplasty. — Reparative or plastic surgery of the nose.

Rhinorrhœa.—A mucous or serous discharge from the nose. *See* Nose, Foreign Bodies, etc. (*Nasal and Cerebro-Spinal Rhinorrhœa*); Hydrocephalus (*Symptoms, Escape of Cerebro-Spinal Fluid by the Nose*); Measles (*Complications, Rhinitis*).

Rhinoscleroma. *See* Nose, Chronic Infective Diseases (*Rhinoscleroma*); Pharynx, Chronic Infective Diseases (*Rhinoscleroma*); Skin, Bacteriology of the (*Rhinoscleroma*); Tumours of the Skin (*Rhinoscleroma*).

Rhinoscopy. *See* Nose, Examination of the (*Anterior and Posterior Rhinoscopy*).

Rhipecephalus Annulatus. — A species of tick which conveys Texas fever to cattle. *See* Malaria (*Historical*).

Rhizodontrypy. — Opening into or puncture of the root of a tooth.

Rhizopoda.—*See* Parasites (*Protozoa*).

Rhodopsin.—Visual purple. *See* Retina (*Anatomy*).

Rhœados Petala.—Red Poppy Petals or those of *Papaver Rhœas*; they contain no morphine but only red colouring matter; there is an official preparation (*Syrupus Rhœados*) used as a colouring agent.

Rhombencephalon. — The hind-brain or posterior cerebral vesicle of embryology, corresponding to the medulla oblongata, pons varolii, and cerebellum. *See* Embryology.

Rhomboideus.—A muscle of the neck having a rhomboid shape.

Rhonchus.—A rattling or snoring sound (Gr. ῥόχθος, a roaring) heard on auscultation over the lungs, and due to narrowing of a bronchus or to the presence therein of tenacious mucus; it has not, correctly used, the same meaning as râle (*q.v.*).

Rhubarb.—The erect rhizome of several varieties of *Rheum* grown in China, Tibet, and America. It contains numerous alkaloids, the most important of which are *chrysarobin, chrysophanic acid,* and *rheotannic acid.* To the first two it owes its purgative properties, to the last its astringency. *Dose* — 3-10 grs. (repeated); 15-30 grs. (one administration). *Preparations* — 1. Extractum Rhei. *Dose*—2-8 grs. 2. Pulvis Rhei Compositus. Gregory's powder. Contains magnesia and ginger. *Dose*—20-60 grs. 3. Pilula Rhei Composita. Contains aloes. *Dose*—4-8 grs. 4. Tinctura Rhei Composita. *Dose*—½-4 ʒ. 5. Liquor Rhei Concentratus. *Dose*—½-1 ʒ. 6. Syrupus Rhei. *Dose*—½-2 ʒ. 7. Infusum Rhei. *Dose*—½-1 ℥.

Rhubarb is an excellent stomachic and purgative for occasional use, as when it is desired to unload the bowels without affecting the general system, or for the purpose of removing irritating materials from the intestine. If used over long periods it tends to cause chronic constipation. It should not be administered alone, on account of the griping it causes. It is specially valuable in the digestive disturbances of children, and in the treatment of irritative diarrhœa whether in children or

adults. As a stomachic it is given in small doses usually combined with bismuth and soda, as a purgative in larger doses in combination with an antispasmodic. Because of the chrysophan it contains it may colour acid urine yellow and alkaline urine carmine.

Rhus Toxicodendron.—The poison-oak or poison-ivy, containing toxicodendric acid; it has been used in chronic rheumatism. *See* Dermatitis Traumatica et Venenata (*Causal Agents, Vegetable*); Myiasis (*Hairy Caterpillars*).

Rhyl. *See* Therapeutics, Health Resorts (*English, Wales*).

Rhythmism. *See* Insanity, Nature and Symptoms (*Insane Defects of Inhibition, Rhythmism or Automatism*).

Ribes' Ganglion.—A sympathetic nerve ganglion situated near the anterior communicating artery of the brain.

Ribs. *See* Chest, Deformities of (*Ribs in Rickets*); Chest, Injuries of (*Contusions, Fractures, and Dislocations of Ribs*); Osteomalacia (*Ribs*); Pleura, Affections of, Surgical (*Empyema, Thoracoplasty*).

Rice. *See* Invalid Feeding (*Rice Pudding, Rice Soup*).

Rice-Water Stools.—The typical evacuations of cholera. *See* Cholera, Epidemic (*Symptoms, Stools*).

Richardson's Mixture.—A mixture of alcohol (2 parts), chloroform (2 parts), and ether (3 parts). *See* Anæsthesia (*Other Anæsthetics*).

Richfield. *See* Balneology (*America, Sulphuretted Waters*).

Richter's Hernia. *See* Hernia](*Structures, Contents*).

Ricin.—A proteid, with poisonous qualities, contained in the castor-oil bean (*Ricinus communis*), and causing toxic symptoms (*ricinism*) consisting of jaundice and hæmorrhagic enteritis and gastritis.

Rickets.

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See also Achondroplasia; Adrenal Glands (*Adrenalin in Rickets*); Alcohol (*Indications in Childhood*); Bronchi, Bronchitis (*Etiology, Predisposing Causes*); Cataract (*Varieties, Lamellar*); Chest, Deformities of (*Deformities in Rickets*); Children, Clinical Examination of (*Head in Rickets*); Convulsions, Infantile (*Etiology*); Deformities (*Rickets*); Fragilitas Ossium; Head (*Shape in Rickets*); Labour, Precipitate and Prolonged (*Pelvic Deformities, Rickety*).

Definition.—Rickets is a chronic disease of early life, in which the chief anatomical changes consist in enlargement of the epiphyses and deformities of the bones, while the ligaments, muscles, and many of the internal organs are also apt to be affected.

Etiology and Pathology.—Rickets in its most typical form occurs between the ages of six months and two years; but the early symptoms are often noted during the latter months of the first half-year; while the results of rickets—in the shape of stunted and deformed limbs—are seen long after the age of two years has been passed. A peculiar form of rickets is sometimes seen in older children and young adults (late rickets).

Rickets is an exceedingly common disease in the large cities of the United Kingdom, as well as in the industrial centres of Europe and North America; it is comparatively rare among the natives of semi-tropical countries such as India, China, and Japan. It is much less common in country districts than in cities, as for instance in a Westmoreland village, where the inhabitants are a sturdy race of farmers and follow outdoor pursuits, than in a Lancashire village or city, where the inhabitants are miners or factory operatives. It is common among a population given to early and improvident marriages, and where in consequence over-crowding and poverty exist, while the infants are artificially fed on account of the mothers going to work in the mills. It is rare among a population where the parents are thrifty and sturdy, and suckle their infants for the greater part of the first year.

The chief predisposing causes of rickets are (1) congenital weakness, (2) unhealthy life conditions, and (3) improper feeding and dyspepsia. Rickets is not an hereditary disease in the sense that rickety parents transmit the disease to their offspring, but there can be no doubt that infants of weakly parents more often suffer from rickets than the infants of robust parents. Unhealthy life conditions undoubtedly predispose to rickets. Among these conditions must be mentioned the influence of a cold and damp climate in producing bronchial and intestinal catarrhs, the continuous breathing of vitiated air in crowded dwellings, the neglect of cleanliness so common among the poor. Life in the crowded dwellings of the poor predisposes

to indigestion, while fresh air and sunlight are powerful factors in promoting digestion and tissue-building.

There can be little doubt that bad feeding and chronic dyspepsia are the most efficient predisposing causes of rickets. Vigorous infants nursed at the breasts of healthy mothers rarely suffer from rickets while being suckled, even though exposed to the life conditions incident to a crowded court. It is the artificially fed infant that suffers, whether fed on condensed milk, starchy foods, or fresh milk. We find for the most part that children who have well-marked rickety deformities have suffered much from indigestion, have been difficult to feed, though many changes of food have been tried, while in some there is a history of long-continued bronchial catarrh. On the other hand, it must be admitted that in some mild cases there has been no obvious indigestion, the surroundings have been all that could be desired, and the feeding carried out with care. It must also be said that bad feeding and continuous indigestion do not always produce rickets; there may be ill-health and wasting in an infant without any of the characteristic signs of rickets. This is also true of experiments on animals,—bad feeding and insanitary conditions will produce ill-health in puppies and other young animals, but very rarely rickets (Spillman).

If, as stated, it is extremely probable that chronic indigestion plays an important part in predisposing to rickets, yet we are in much ignorance concerning the immediate or exciting cause. Some writers (Heitzman, Monti) have laid great stress on the lactic acid fermentation which takes place in chronic dyspepsia; they aver that in consequence of a deficiency of HCl in the gastric juice there is an imperfect solution of lime salts and also an excessive formation of lactic acid, large quantities are absorbed into the blood, and this lactic acid poisoning is the efficient and immediate cause of rickets. It has also been suggested that rickets is due to an imperfect oxidation of the blood in the lungs, in consequence of the bronchial catarrh so often present, and collapse of lungs in connection with the misshapen chest. It is quite safe, however, to say that neither of these hypotheses go very far in explaining the causation of rickets.

The trend of modern opinion is rather in the direction of seeing in rickets the results of the absorption of toxines from the alimentary canal, which are formed during a period of chronic indigestion. The sweating, the muscular paresis, the laryngismus and convulsions, suggest the presence of toxines in the blood, which have been formed in the alimentary canal from the maldigestion of the proteids, fats, or starches in the food. It is very possible that several allied toxines may be formed which give rise to special symptoms. Thus in some cases the bone changes are most in evidence, in others the muscular system chiefly suffers. In other cases convulsions, tetany, and laryngismus are present, while in others they are absent from first to last. Thus it would seem likely that rickets is the result of a peculiar form of chronic dyspepsia, in which certain toxines are formed from bacterial action, and it is the passage of these toxines into the blood from the alimentary canal that gives rise to the pathological changes which take place in this disease.

Clinical Features and Course.—The early symptoms of rickets do not always include well-marked deformities or any evidence of softening of the bones. Before these changes occur there is a period during which the symptoms are rather those of subacute or chronic indigestion, with great irritability and night sweats. These early dyspeptic symptoms include flatulence, constipation, foul-smelling stools, restlessness and wakefulness at night, sweating followed by plentiful crops of miliaria, very possibly there may be convulsions. Such symptoms may be noted as early as the fourth or fifth month, but oftener, perhaps, not till a few months later. The infant is usually a notoriously bad sleeper, it keeps its mother or nurse awake for hours together because it cannot rest, and when it does doze its sleep is broken, and beads of perspiration appear on its forehead and scalp, while its skin and night-clothes become damp and clammy. The miliaria with which the body becomes covered is probably attributed by its nurse to "teething." It is very apt to continually rub the back of its head against the pillow, with the result that the hair is worn off at this spot.

The marked restlessness which is often such a marked feature in early rickets is no doubt due to the flatulence and distension so often present, but very probably also the bones may ache or be more or less tender. When the bones are acutely tender an associated scurvy is almost certainly present.

If these symptoms persist for many weeks or months some evidence of rickety changes in the bones and muscular paresis are sure to be present. Perhaps the occipital and parietal bones will be abnormally thin, and readily yield to the pressure of the finger (cranio-tabes), and the former may become more or less flattened from pressure of the head on the pillow when lying on the back. Or the eminences of the frontal and parietal bones begin to appear unduly prominent, giving the infant's head a heavy, square look. An examination of the chest may show that the chest wall is being sucked in on each side of the sternum during inspiration in consequence of a want of rigidity of the ribs and their cartilages; the swellings at the junction of the ribs and cartilages may be exaggerated. All these signs may be noted before six months of age, but they are, perhaps, more usually noted somewhat later.

The infant may in this early stage be subject to convulsions without any very obvious cause, and also laryngismus and tetany may occur, but the two latter are more common during the second year. In spite of its evident ill-health the infant probably does not waste to any extent, and may be very well nourished as far as fat is concerned. Some infants at this period suffer much from bronchial catarrh, and they very easily "catch cold." The muscular system is almost certain to be weak, and the infant is late in learning to hold up its head or in attempting to sit up. The urine has often a peculiar strong smell, likened by some to trimethylamine.

The course of the disease if not checked by treatment is essentially chronic. As time goes on no teeth make their appearance at the usual time, the head becomes more markedly square, the chest more deformed, the epiphyses at the wrists and ankles enlarge, the infant cannot sit up, and perhaps cannot hold up its head. At the end of the first year, if the case is severe, the child presents a typical picture. The head is large and square, and out of proportion as compared with the stunted limbs, the chest is narrow and deformed, the abdomen is large and round from the presence of gas in the stomach and the intestines, and in some cases an enlarged liver and spleen can be felt. The rickety rosary can be seen or felt, and the epiphyses at the wrist and ankle are very prominent. The child cannot sit up without help, and is quite helpless as regards crawling or standing alone; its ligaments are weak, and its muscles very poorly developed. It is perhaps anæmic, in some cases markedly so.

During the second year the most characteristic feature consists in the curvatures of the long bones. The child uses its limbs more or less at this period, and there is therefore a greater danger of their bending than earlier. When the child sits up in bed or on the floor it rests a certain amount of weight on its arms, and a curvature with the convexity outwards perhaps takes place in the bones of the arm and forearm. But the lower ends of the tibia and fibula are more likely to bend than the arms, when the child sits on the floor with its legs crossed or doubled under it; the bones perhaps bend with a sharp curve inwards in their lower third. If the child sits up, either by itself or is propped up, the spinal column is very likely to give way, the whole length of the spine bowing backward (kyphosis). The digestion is probably very poor, it cannot digest well, especially the curd of milk, and its stools are pasty and foul smelling. At this time laryngismus is common, and so also is a persistent bronchial catarrh, which returns again and again.

The child may remain more or less in this state during the whole of the second year. The teeth appear slowly; it is very slow in making progress in crawling or in attempting to stand alone. The limbs remain more or less stunted, the muscles soft and flabby, the joints loose from laxity of the ligaments. The child is probably late in learning to understand or talk, and is backward in mental development. It may perhaps learn to stand alone during the third year, or there may be still further delay. It is after that it has learned to get about on its legs that the knees give way and knock-knees appear. Some children remain for years making but little advance and being practically bedridden. Others are able to get about with a waddling gait in consequence of knock-knees and perhaps coxa vara; they are stunted in body and backward in intelligence.

It is hardly necessary to say that the above description applies only to a severe case, and the combination of signs and symptoms may differ. It may happen the rickets may be fairly severe, and yet the head is of a normal shape, while the deformity of the chest is considerable. Or the epiphyses of the wrists may be normal, the chest fairly well formed, but the muscles are flabby and the joints loose, so that at two years old the child is not walking, and very likely not talking. In some others laryngismus may be very severe, and but slight curvatures or deformities of the bones present.

In other cases, again, the infant is abnormally pale and fat, the muscles are flabby and weak, and there are no marked departures from normal as far as the bones are concerned.

Having sketched the course of the disease, a more detailed description of some of the more important signs and symptoms may now be given.

Head—Cranio-tabes—Natiform Skull.—It is not uncommon to find in examining the heads of infants, especially those who are wasting or not doing well, that in places, or all over generally, the occipital and parietal bones are abnormally thin, and can be pressed or bent in by pressure of the fingers. In examining an infant's head in this way it is well to avoid the sutures and posterior fontanelle, as the most characteristic patches of atrophy are usually nearer the centres of the bones. The whole of these bones may be abnormally thin from defective calcification, or there may be small patches scattered about which consist simply of membrane. Cranio-tabes was described as being a sign peculiar to rickets by Elsasser many years ago. Since his time it has been attributed to syphilis by Parrot and others. There is no doubt that it occurs in rickets, but it is not pathognomonic, as it occurs not uncommonly in cases of malnutrition which are not rickety. It is doubtful if its connection with syphilis is anything more than a casual connection, though this is not the universal opinion. It has already been noted that at times the ossification of the occipital bone is so

defective, that it becomes flattened in by the pressure exerted by the weight of the head resting on the pillow. Elsasser took an exaggerated view of the importance of cranio-tabes, and attributed some of the nervous symptoms occurring in rickets, as laryngismus, to the thinning of the bone, but this is very doubtful. While cranio-tabes is not pathognomonic, in all cases of marked thinning of the occipital or parietal bones rickets should be suspected. More certainly characteristic of rickets is the square head and the natiform skull. The former is much the more common, and may often be noted before the infant is six months old. It is the result of an excessive formation of spongy bone at the centres of ossification of the frontal and parietal bones. The result is a flattening of the superior surface, a certain squareness in appearance as well as an increase in the circumference of the head. The edges of the bones bordering on the fontanelles can be felt to be thickened, though perhaps abnormally soft, and the fontanelles are widely open for the age of the infant. The natiform skull is often present in severe rickets, and indeed only appears in severe cases. There are two broad grooves on the top of the head corresponding with the longitudinal and transverse sutures, and therefore at right angles to one another, giving the upper surface of the skull a sort of "cross bun" appearance, while the four quarters of the upper surface are raised as bosses (Parrot's bosses). The edges of the bones forming the grooves are mostly membranous, and often cranio-tabes is present. Many believe the natiform skull is a sign of syphilis (Carpenter).

Dentition is mostly delayed, and the appearance of the teeth through the gums may be out of their usual order. In some cases the two lower central incisors may appear at the normal time, then rickets may supervene, and there is a long delay before others show themselves. In some cases of rickets the milk teeth quickly become carious, but this is not constant. The fontanelles are slow in closing, and the edges of the bones which form their borders are apt to be thickened and softened from deficient calcification. The fontanelles may be found widely open at two years old, or indeed at times as late as four years old; whenever there appears a delay in these openings closing up, rickets may be suspected.

Chest.—In marked contrast to the large head and rounded abdomen of rickets the chest is narrow and constricted. At the junction of the ribs with their cartilages, especially the fourth to the ninth, there are enlargements which form a row of prominences, the so-called rickety rosary. Both ribs and cartilages lose their rigidity in a more or less marked degree, and as a result of this, part of the chest wall is sucked in during inspiration, and shallow, broad grooves are formed on both sides of the sternum; the latter is more or less thrust forward, and thus the so-called "pigeon" chest is formed. The typical rickety chest, however, is not the true "pigeon chest"; in the rickety chest the sternum and cartilages are thrust forward from falling in of the ribs, and the protuberance is rounded. The pigeon chest with the keel-like ridge is due to softening of the cartilages in later childhood. In other cases the groove is horizontal and corresponds with the attachment of the diaphragm, the chest wall is pulled inwards, and the lower edge of the chest wall everted. This groove is sometimes known as Harrison's sulcus. Should the infant suffer from bronchitis the chest deformity will tend to become aggravated, and it is certain that the deformity and want of rigidity of the chest wall greatly adds to the danger of an attack of severe bronchitis or broncho-pneumonia. As the child gets older the chest deformity tends to become less marked, the ribs become more firm, but usually more or less deformity remains for life.

Limbs.—The deformities of the bones of the limbs mostly occur at a later date than those of the head and chest. They consist for the most part of an exaggeration of the normal curves, and they are brought about by the child using its limbs for some purpose or other such as locomotion. The commonest is a curving inwards of the tibia and fibula in their lower thirds, and this is most commonly produced by the child sitting up in bed or on the floor with its knees flexed and perhaps the feet crossed. Almost any movement of the feet in raising itself or in progression will tend to curve the tibiæ inwards. If the child habitually supports itself in the sitting position with its arms, both the bones of the arm and forearm will tend to be bent with the convexities outwards. The curve assumed by the femur is mostly forwards and outwards; bending of the neck of the femur is also apt to take place (coxa vara), (*see* DEFORMITIES, vol. ii. p. 295). Enlargement of the epiphyses of the long bones is sometimes very noteworthy, especially at the wrists and ankles. Irregular outgrowths of bone are apt to take place in various places, as, for instance, the rickety tubercle often present on the inner side of the head of the tibia, and the outgrowth of the inner condyle of the femur in knock-knee.

Muscles and Ligaments.—The malnutrition and weakness of the muscles is as constantly present in rickets as the deformities and softening of the bones. The voluntary muscles are all poorly developed, so that perhaps at a year old, or even later, the infant makes no attempt at sitting up or even holding up its head. For long after it can sit up in a sort of fashion, its back is likely to be weak on account of the laxity of the ligaments and the erector spinæ group of muscles. There is usually a general

bowing backwards of the spine, the natural curves being lost in the general bend. By the end of the second year the child may have made no progress in crawling, or walking, or standing. In other children who have managed to get on their legs the stretching of the ligaments plays an important part in the production of knock-knees, flat feet, and later curvatures of the spine.

Complications and Associated Conditions. —Rickets is often associated with various conditions, and it is difficult to say if they are an integral part of the disease or complications.

Bronchitis and Broncho-pneumonia. — Many rickety infants suffer a good deal from bronchial catarrh; they seem exceedingly sensitive to cold, and in consequence are kept indoors in an over-heated, badly ventilated room for months together. Sometimes the bronchitis is associated with laryngismus. There can be no doubt, also, that infants who suffer much from bronchial catarrh, and are kept in the house and deprived of fresh air, develop severe rickets. The deformity and want of rigidity of the ribs, as well as the weakness of the muscles of respiration, predispose to these catarrhs. Broncho-pneumonia is apt to be very fatal in rickety children.

Gastro-intestinal Catarrh. — The enlarged rounded abdomen is always present in a well-marked case of rickets. There is a constant formation of gas in the stomach and bowels in consequence of the fermentation of the food, while the muscular coat of the intestines is poorly developed and toneless; this tends to the stagnation of the imprisoned gas. In some cases, at least, the stomach is also dilated and constantly distended. Constipation, which is so common in rickets, is due also to the toneless state of the muscular coat of the intestines. Chronic indigestion is very commonly present as an early symptom, and is mostly present during the first two years or more. Through the whole course of rickets the digestion is weak, and the stools apt to be pale in colour and fœtid.

Scurvy.—Rickets and scurvy are frequently associated with one another. In severe cases of rickets there is frequently a certain amount of tenderness of the bones and perhaps no other sign of scurvy. All degrees of scurvy may be present in a bad case of rickets (*see* "Scurvy, Infantile").

Syphilis. — Since the days when Parrot asserted that congenital syphilis was the real cause of rickets, there has been a good deal of difference of opinion as to the part syphilis has played as a complication of rickets, if certain signs and symptoms often seen in cases of rickets were to be regarded as due to syphilis or not. No one now believes that syphilis has anything to do with the causation of the majority of cases of rickets, but there is some difference of opinion as to whether the natiform skull, cranio-tabes, anæmia with enlarged spleen, etc., should be regarded as signs of syphilis or not. While the subject cannot be looked upon as settled, it is certain that both the natiform skull and anæmia with enlarged spleen are associated with marked deformity of the bones in the immense majority of cases. It is clear, however, that syphilitic children often become rickety.

Anæmia and enlarged Spleen.—In many cases of rickets there is no anæmia, and indeed children with rosy faces may be seen who are unable to stand alone, and have bent legs and deformed chests. An enlarged spleen is by no means constant in rickets, but in the earlier stages of rickets and in a severe case there is often marked anæmia, and at the same time there is, perhaps, also an enlarged spleen to be felt some few fingers' breadth or more below the ribs. Marked rickets, striking pallor, and a spleen reaching two or three inches or more below the edge of the ribs, form a not uncommon combination of symptoms in children, especially during the second year. These cases, when well marked, have been described as "splenic anæmia" or "pseudo-leukæmia infantum," but according to the writer's experience the signs of rickets are almost constantly present. The natiform skull, the rickety rosary, and enlarged epiphyses are commonly seen. It is not possible to say in these cases if rickets is the primary disease, and the splenic anæmia secondary and dependent on the rickets; certainly, as regards time of onset, rickets often comes first. It has been suggested that these cases are a combination of rickets and syphilis, but a history of syphilis is often absent, while the signs of rickets are almost universally present. An examination of the blood in these cases shows a diminution of the number of the red corpuscles (2,000,000 to 3,000,000 per cm.) and an increased number of leucocytes (25,000 to 30,000 per cm.), also many nucleated red corpuscles. There seems to be no constant departure from the normal with regard to the different leucocytes present. These cases are essentially chronic, but usually improve under treatment, the spleen diminishing in size and the number of blood corpuscles increasing. If death takes place it is usually through some complication, as measles or pneumonia. The writer has seen several of these cases, when four and five years of age, with more or less rickety deformity remaining, the spleen still to be felt well below the ribs, and some slight anæmia. Apart from the cases just referred to, in which there is a very noteworthy hypertrophy of the spleen, most authors agree that there is a more or less enlargement of the spleen during the course of some cases of rickets, but that this enlargement is not constant. Cohn found the spleen enlarged 58 times in a clinical examination

of 858 rickety children. Kuttner noted enlargement in 44 out of 60 cases of rickets; in 33 of these the edge of the spleen could be felt under the border of the ribs, in 9 cases the edge came two fingers' breadth below the ribs, and in 2 the hypertrophy was very considerable. There is no agreement among authors as to whether the hypertrophy of the spleen is an essential part of the disease, or whether it is secondary to some complication so often found in association with rickets. Whatever view may be taken of the slighter enlargements, there can be no doubt that when a well-marked anæmia is present it is constantly associated with splenic enlargement.

Skin.—The profuse sweats so common in rickets are apt to give rise to crops of miliaria or intertrigo in the folds of the neck and groins, and perhaps troublesome boils. Eczema of the face and scalp is also apt to be very troublesome in a rickety infant. During sleep the sweatings aggravate the eczema, and much weeping is the result. The exudation cakes and scabs as it dries up. In such cases convulsions, high temperature, and sudden death may take place.

Nervous System.—Rickety children are apt to be backward in intelligence, being late in learning to talk as well as in learning to walk. They are apt to be lethargic and apathetic, and disinclined to exertion of any sort. Rickets certainly predisposes to convulsions; these may come on as early as the fourth or fifth month, or at any time during the first or second year (*see* "Convulsions"; *see also* "Larynx, Laryngismus," and "Tetany").

Fractures.—Rickety bones are apt to break as well as bend; the fractures are usually of the "green stick" variety, *i.e.* the fractured ends are held together by the thickened periosteum, usually at a more or less acute angle. The ribs may kink at or near their angles, the fractures involving four or five or more of the middle ribs. Fractures of the middle third of the humerus may occur when the child is lifted by its arms, the tibia is apt to kink at the usual seat of bending in the lower third. Fractures of the femur, clavicles, and bones of the forearm are not uncommon. In some of the cases of fracture scurvy may be present. Separation of the epiphyses may take place under similar circumstances.

Morbid Anatomy.—In the healthy infant of four or five months of age the shafts of the long bones are completely ossified, while the epiphyses, with one exception, consist entirely of cartilage. The bones grow in length by ossification taking place between the epiphysis and shaft, and in girth by the formation of compact bone between the inner layers of the periosteum. The bones of the skull are also fully ossified at this time with the exception of the edges where they form the fontanelles. It is at this period, or somewhat later, that rickets is liable to supervene, and a pathological process succeeds the normal physiological process of bone formation.

In making a post-mortem of a case of severe rickets, the deformed chest, bent ribs, with rows of prominences or "beads" at their junction with their cartilages, will at once strike the attention. The "beads" will be seen to be as marked or more so on the pleural as on the cutaneous side. On removing a rib it will be found that it is easily bent or kinked, and that it has lost most of its normal rigidity and elasticity; the periosteum is thick, so that when the bone is broken between the fingers the two ends are held together by the external fibrous tissue. If a longitudinal section be made by a knife through the swollen anterior end it will be seen that the greater part of the swelling involves the cartilage (the columnar zone), while the epiphysial line which marks the boundary between bone and cartilage is deeper and much more irregular than in healthy bone. A transverse section of the rib itself shows an almost complete absence of compact tissue; only spongy bone is seen, and much red grumous material. An examination of the radius will probably show similar changes; the bone can be bent or broken between the fingers, and section through the epiphysis will show swollen cartilage and a broad, irregular epiphysial line. The bones of the vault of the skull are abnormally soft, can be easily doubled up between the fingers, and cut with a knife. The ossifying centres, *i.e.* the parietal and frontal eminences, are thickened, and on cutting into them they show much soft, spongy tissue; the edges of the bones are thick and soft. Instead of or in addition to the thickening just referred to there may be atrophic changes; the parietal and occipital bones, when stripped of their dura mater and held up to the light, are seen to be thin and transparent in places, where calcareous matter has been absorbed and left membrane only. Rickety skulls are apt to be large ones, at least in their circumference, on account of the exaggerated condition of the frontal and parietal eminences; their internal capacity, also, is at times apparently increased, as the brain is sometimes of abnormal size. There is no association between rickets and hydrocephalus, though children suffering from chronic hydrocephalus may become rickety.

Summarising the changes produced by rickets, it may be said that rickety bones in their early stages are characterised by swelling of the epiphyses, thickening of the periosteum, decrease of lime salts, increase of the red gelatinous medullary material, with the result that the bones are softened, fragile, and stunted in growth.

If death take place at a somewhat later period the bones will be found more or less curved or

bent, and possibly evidence of fractures will be present. In a later stage the bones will be found firmly consolidated, often presenting an ebony-like hardness.

The exact nature of the bone changes in rickets, whether inflammatory or not, remains for the present undecided. It is tolerably certain, however, that these changes are not primary, but that they are secondary to some general disease. If a section be made through the beaded end of a rickety rib, and an examination be made under a low power, it will be seen that the swollen end corresponds with the lower zone of cartilage in which the cartilage cells have undergone proliferation, and are arranged in columns. It is clear that an abnormal amount of proliferation has gone on, that the matrix has undergone softening, and there is a bulging which corresponds to this columnar zone. Next to and beneath this zone is the epiphysial layer —which normally is narrow and sharply defined —in which the provisional calcification is proceeding by the deposit of earthy salts in the matrix of the cartilage; beneath this again is the zone where true bone is being formed through the medium of the osteoblasts and blood-vessels. In a case of severe rickets this epiphysial line is very irregular, and is made up of irregular areas of uncalcified cartilage belonging to the columnar zone, patches of calcified cartilage, and osteoid tissue in which no calcification has taken place, with also medullary spaces and blood-vessels. It will be seen that the preparation for ossification is excessive and much beyond the normal, but in spite of a sufficiency of lime salts very little calcification takes place. For some reason the cartilage matrix and the osteoid tissue are unfit for the deposition of lime salts; the formation of true bone is retarded, and the net result is fragile and soft, cancellous tissue with large spaces filled with red gelatinous material. Beneath the periosteum there is also an excessive amount of cell formation, while calcification is retarded, and instead of compact tissue a spongy mass is formed.

In connection with the changes which occur in the bones in true rickets, it is interesting to compare the changes noted in the bones of young animals fed on foods poor in lime salts, and in which a sort of pseudo-rickets takes place. Stoeltzner fed a six weeks' old puppy on raw horse flesh, bacon, and distilled water, a food poor in lime salts. The animal gained in size and weight during the research, which lasted eight weeks.

Ten days after the commencement of the experiment the bones appeared to be tender, there was some swelling of the epiphyses, beading of ribs, and bending of the long bones of the limbs. An examination of the bones at the section showed swelling of the ends of the ribs corresponding to the columnar zone of the cartilage, some thickening of the periosteum, and a high degree of osteo-porosis that at first sight appeared identical with rickets. A careful examination showed that this osteo-porosis differed essentially from rickets, in that in rickets an excessive preparation for ossification took place, viz. a rich formation of osteoid tissue, which, however, remained almost uncalcified, while in osteo-porosis but slight preparation—much less than normal—took place, and in spite of the scarcity of lime salts this little was calcified. Also in osteo-porosis, in opposition to rickets, the cartilage matrix, in spite of the insufficiency of lime salts, became calcified.

Visceral Lesions.—Various lesions are apt to be found post-mortem in children who have suffered from rickets, but for the most part they are complications rather than integral parts of the disease. Thus bronchitis, broncho-pneumonia, collapse of lung, and emphysema may be present, and have brought about the fatal result. Catarrh of the stomach and intestines is frequent, and a considerable degree of dilatation of the stomach and also of the large bowel may be noted. Huguenin observed a dilated stomach in an infant suffering from severe rickets, and who died of broncho-pneumonia at the age of ten months, which reached nearly to the umbilicus, and Baginsky has related a similar case. The liver also is often notably enlarged, and in some cases fatty.

Reference has already been made to the frequent enlargement of the spleen in rickets. Stark found the spleen enlarged in 53 cases out of 93 post-mortems on children suffering from rickets, who had died of broncho-pneumonia, gastro-intestinal catarrh, pleurisy, or anæmia. He found no macro- or microscopic changes in the organ peculiar to rickets, and he believes that the enlargement is due to complications present. Sasuchin, on the other hand, who has recently examined twelve hypertrophied spleens present in rickety children, believes the changes he found to be characteristic of rickets. The largest spleen he examined weighed 51·2 grammes (normal weight 20·4), from a child of twenty months who died of broncho-pneumonia; there were marked changes in the bones, including enlarged epiphyses and genu valgum. The changes found in all the spleens examined suggested chronic inflammation, thickening of the capsule and trabeculæ, atrophy of the Malpighian bodies, and narrowing of the arteries. He made control examinations of spleens of children dying of broncho-pneumonia, etc., without rickets, and failed to find these changes.

Fœtal Rickets.—It may be said with certainty that many of the cases which in times past have been reported as cases of fœtal rickets had very little in common with true rickets. Parrot first separated achrondoplasia from the intra-uterine bone lesions due to other causes. In achondroplasia or chondro-dystrophia fœtalis the bones of the extremities are extremely stunted

and bent, while the bones forming the vault of the skull and also the chest are fairly well developed (see "Achondroplasia"). Stœltzner has recently reported a case of "fœtal myxœdema," in which the limbs were bent and stunted, while there was some enlargement of the epiphyses, but in general the case far more closely resembled achondroplasia than rickets. After excluding the above conditions there remain a large number of observations on congenital bone disease which vary considerably, and probably own a variety of causes. Most will be inclined to agree with Ballantyne when he says of this class, "We have not yet reached a time when a scientific classification founded on pathological lines is possible."

The class of cases which most resemble rickets are those in which fractures occur during birth or shortly afterwards, and in which there is cranio-tabes, misshapen chest walls, and less often curvatures and enlarged epiphyses. Such cases have been published by Osgood Mason, Townsend, H. Ashby, and others. They all agree in that the infants were born with imperfectly calcified bones, especially of the skull, ribs, and bones of the limbs, fractures readily took place, and in some reported cases the bones were bent and the epiphyses were enlarged. Were they cases of true intra-uterine rickets? Certainly they have a close resemblance clinically, but, on the other hand, it seems not unlikely they more closely resemble the osteo-porosis or osteo-genesis imperfecta produced by feeding puppies and other young animals on food deficient in lime rather than true rickets. More observations are needed in examining the bones of fatal cases by modern methods before their true nature can be definitely stated.

Late Rickets.—While rickets in its typical form only occurs during the first two or three years of life, yet during the whole time growth and development are in progress some of the signs and symptoms of rickets may make their appearance. After the epiphyses have become ossified and joined to the shafts it is hardly possible for rickety deformities to occur. The symptoms of "late rickets," which usually supervene before puberty, consist in perspirations, fatigue on slight exertion, gradual enlargement of the epiphyses of the long bones, especially marked at the knees and ankles, weakness of muscles, laxity of ligaments, producing various deformities, such as lateral curvature of the spine, knock-knees, and flat feet. Enlargement of the head, curvatures of the long bones, deformity of chest belong rather to the period of early than late rickets, yet in exceptional cases they may occur. Many of these cases are probably relapsed rickets. In severe cases the child or young adult is reduced to a complete invalid, and often more or less of a hypochondriac. He is tired at the least exertion, complains of pains in the bones, is very nervous and irritable, and has to lie up nearly the whole of the day. Such cases may remain for years in the same condition. If the patient is a boy he is unfit for school, and probably loses many years of his school life. The subjects of late rickets are frequently lanky, overgrown boys or girls.

While the above description applies to a fairly common type of case met with during late childhood or early adult life, in rare cases the disease which thus commences late is much more severe, and the deformities of the bones much more resemble the type of rickets seen during the second year. In some of these patients there is a history of having suffered more or less from rickets at the usual period; they have apparently got well and remained so, perhaps, for some years, and then there has been a relapse. In other cases there is no such history, there has never been any bone deformity till at or after puberty; it is noticed that they begin to have a waddling gait, the legs begin to bend, there is a very marked enlargement of the epiphyses of the bones forming the ankles, knees, wrists, and perhaps the elbows and shoulders. These deformities may be accompanied by pains and achings in the bones. Beading of the ribs may occur. In some cases deformities of the chest have been observed, and in one rare and remarkable case published by James, in which the disease began in a youth of seventeen years, the skull enlarged in addition to the other deformities described. In one case recorded by Clutton, a post-mortem examination confirmed the diagnosis of late rickets made during life.

Diagnosis.—There cannot be any difficulty in recognising a case of rickets in a child under two years of age if the usual symptoms and signs, such as sweating, deformities of bones, muscular weakness, etc., are present. There may be uncertainty in the early months when there is only sweating, or indigestion, or convulsions; and later on, when rickets is present, the difficulty may arise in deciding how far some of the symptoms present are due to rickets or to some other cause. Thus a rickety child of three or four years old may suffer from fits. Are these fits epileptic, or are they the result of the rickets? In some cases the muscular weakness is so great in rickets that it is apt to be mistaken for paraplegia. When the rickety child is just able to walk, his waddling gait and difficulty in rising from the floor will perhaps suggest pseudo-hypertrophic paralysis.

As already pointed out, the difficulty of determining whether in a given case the infant is suffering from hereditary syphilis and has become rickety, or whether the signs and symptoms present are due to rickets alone, is very great. Thus an infant of five months old suffers from eclampsia, coryza, anæmia, has a

natiform skull and beaded ribs. There is no history of rash or of syphilis. The spleen is enlarged. Are the natiform skull and enlarged spleen due to syphilis or rickets?

Prognosis.—Rickets *per se* is never fatal, but the presence of severe rickets immensely adds to the danger of an attack of bronchitis or broncho-pneumonia. Both measles and whooping-cough are very fatal in rickety children under two years of age. The loss of rigidity in the chest walls and the consequent sucking in of the ribs during inspiration prevents the clearing of the bronchi by coughing, and tends to passive congestion of the lungs. Sudden death may at any moment occur in a child with severe rickets and laryngismus; the writer has made several post-mortem examinations on children with marked rickets, who died suddenly from asphyxia, the result apparently of spasm of the glottis, who had never been heard to "crow" or known to have suffered from attacks of respiratory spasm.

Apart from complications rickets tends to get well. The bones harden, and in cases of slight deformity tend to regain their normal shape. The more marked deformities may be lifelong.

Treatment.—If, as alleged, unhealthy life conditions, improper food, and chronic dyspepsia play an important part in the causation of rickets, it is evident that the general principles of treatment must be to place the infant or child under the most favourable hygienic conditions, and to supply it with a "living" food which it can digest and assimilate.

To remove the infant from city to country or seaside, where it will have an abundance of fresh air and sunlight, will be a wise procedure if circumstances permit; in any case arrangements must be made to give the infant as much fresh air as possible, though on account of the tendency so many rickety infants have to bronchial catarrh the daily outing is a time of some anxiety. No rickety infant, though suffering from bronchitis, will flourish or improve if confined to a close and ill-ventilated room, where a steam kettle is sending forth volumes of steam and saturating the atmosphere with moisture. If the infant is confined to the house, wherever it is possible two rooms should be reserved for it, the unused room being flushed with fresh air while the other is being occupied. Whenever the weather permits the child should spend the greater part of the day in the open air. Care should be taken with its clothing: Shetland wool vests, abdominal belts with drawers of the same material, form light and warm articles of clothing.

The most important matter in connection with the treatment of rickets is the question of food. It is useless to prescribe a theoretically correct food if the child cannot digest it; it is no use ordering large quantities of fresh milk if the infant is passing white, curdy, stinking stools; it is probably already taking more than it can digest, and to add more means an addition to an already overburdened digestive apparatus, and a still greater amount of proteid-toxine poisoning. If the infant is seen in the early stages for the first time, the first step will be to secure an effective evacuation of the decomposing contents of the bowel, and to supply a food that the child can digest. Thus an infant of eight or nine months of age is sweating and restless, there is chronic dyspepsia, the ribs are beaded, the stools white and dry. It is certain that in such a case the gastric, intestinal, and biliary secretions are weak, milk curd is badly digested, and the whole digestive apparatus is overtaxed. While fresh milk in any quantity is not well borne, yet thick foods, starchy foods, condensed milk, dried milk foods, pancreatised food, are out of court, or at any rate should not be used except as temporary resorts. If pancreatised food is used at all it should not be given at every meal, and the digesting process should not be carried too far. It is well to begin with a thin food to test the infant's powers of digestion, such for instance as whey (*see* vol. i. p. 326), given in quantities of say 30 oz. with $\frac{1}{2}$ oz. of sugar of milk in the twenty-four hours. If the stools appear more healthy, the amount and strength of the food may be increased by the addition of milk or cream; 5 to 10 oz. milk may be added to the 30 oz. of whey after the latter has been scalded. An ounce of milk-sugar may be added. Instead of the milk a weak cream (made by standing a quart of milk in a glass jar for five or six hours and taking the upper 10 oz.) may be used, but the stools must be carefully watched while the food is being made stronger, and any sign of indigestion is a signal to reduce the strength. Weekly weighings are advisable, remembering, however, rickety children may put on fat without being any better as far as their rickets is concerned.

It often happens that these infants cannot digest any quantity of milk, and as soon as the latter is pushed they fall back into their old dyspeptic state. In such cases raw beef juice or plasmon or somatose may be added to the whey instead of milk. In some cases, at least, small quantities of oatmeal or finely ground whole meal flour may be given with the food. The constipation is often very troublesome, yet it is important to secure a daily evacuation; for this purpose a few grains of carbonate of magnesia may be added to each bottle of food, or syrup cascara aromat. may be given in 5 to 15 drop doses three times a day, and continued for weeks together if necessary. Given in small and repeated doses, and perseveringly used, this drug is usually very efficacious in sluggish conditions of the large bowels. Orange juice should be given daily, especially if the proportion of milk taken is comparatively small.

During the second year we have a greater variety of foods at our disposal, such for instance as eggs, scraped raw beef, marrow of bone, chicken, and beef tea, as well as cream and whey, light puddings, and thin gruel. It is very possible that the rickety child at this age will digest milk badly, and the tendency of nurses is to give more than it can digest, or, on the other hand, too much thick, starchy food, as bread and butter. Scraped raw beef is of undoubted value, but the quality of the beef should be daily carefully examined, as the risk of tape-worm is considerable, and the writer has seen more than one case in which tape-worm was introduced in quite young children by the use of infected raw beef. Thin sandwiches made with cooked bone marrow are very readily taken by young children.

In prescribing a diet for a severe case of rickets in a child eighteen months to two years of age, it should be borne in mind that it cannot digest milk any better than say a healthy infant of four to six months. Mixtures of milk and whey are useful, as the latter contains nearly all the lime and phosphates of the milk.

Diet for a Child of Eighteen Months. Rickets severe (no solid food, 20 oz. of whey with 10 oz. of milk)—

7.30 A.M.—8 oz. of milk and whey, with the addition of rusks, bread-crumbs, or a tablespoonful of well-boiled oatmeal porridge.

10.30 A.M.—8 oz. of whey and milk.

1.30 P.M.—Beef tea, with shredded underdone beef added, or egg with strips of toast, or finely pounded underdone beef, or mutton and fruit juice, or baked apple pulp.

4.30 P.M.—8 oz. of milk and whey, with some cereal added.

7.30 P.M.—Milk and whey or beef tea.

In milder cases, or as improvement takes place, give cream, bacon fat, light puddings, and bread and butter.

Of medicines the most important are those which assist digestion and help to secure a daily thorough evacuation of the bowels. Of the former, nitro-hydrochloric acid dil. 1 to 3 minims, liq. euonymin et pepsin 15 to 20 minims, aq. laurocerasi 5 to 10 minims, sp. chloroformi 2 minims, syrup and aq. to 2 drachms, form a useful combination. "Mist. rhei. co." given in conjunction with a dose or two of hyd. c. cret. every week answers well in many cases. For regular and long-continued use as a tonic laxative the syrup cascara sagrad. is the best drug that can be used. Glycerine and oil enemata may at times be necessary, but they are not good for continual use. Cod-liver oil, especially in the form of emulsion, is of unquestioned service, but perhaps more so in the second year than earlier; and when the digestion is not greatly impaired, lipanin, *i.e.* olive oil with 6 per cent of oleic acid, is recommended by Freyberger instead of cod-liver oil, as it emulsifies better. Iron, arsenic, and iodine are usually given in the anæmic cases with enlarged spleens; or Levico water may be given (blue label) in doses of two to four tablespoonfuls daily; iron somatose, or Hommel's hæmatogen, are also useful when iron is indicated.

Phosphorus has been strongly recommended, especially by Kassowitz, Wegner, and Jacobi, in the treatment of rickets, but it is comparatively little used in this country. Wegner and Stoeltzner have shown that in animals it produces a sclerosis of bone tissue. Freyberger claims for phosphorus that it is useful in laryngismus in doses of gr. $\frac{1}{200}$ once or twice a day. The following combination may be given: Phosphor. $\frac{1}{12}$ gr., ol. limonis 2 minims, lipanini 3 oz., half a teaspoonful twice daily for a child of two years (Freyberger). The elixir phosphori (B.P.C.) may be given in 10 to 15 drop doses, two or three times daily.

Von Mettenheimer has recommended extract of thymus gland in the treatment of rickets, and used it with apparent success, but his success has not been confirmed by others.

More recently, Stoeltzner has claimed for the extract of suprarenal gland a specific action in rickets; according to this authority it exerts a marked influence in checking the sweating, influencing favourably the eruption of the teeth, as well as the calcification of bone. In some of the post-mortem examinations made by him on rickety children that had been treated by this extract and had died of some complication, he has, he believes, found evidence of its action in modifying the course of the disease as far as the bone formation was concerned. The dose he uses to commence with is half a five-grain tabloid (B. W. and Co.) daily for a child of 18 lbs. weight. Stoeltzner found the suprarenal extract was of no use in laryngismus; for the latter he uses phosphorised cod-liver oil.

During the second year of life, and sometimes later than this, much difficulty may be experienced in preventing deformities of the limbs and spine. The bones are soft in severe cases of rickets, and the ligaments readily stretch and deformities ensue in spite of much care. In children in hospital confined to their cots, the tibiæ will bend inwards in their lower thirds from the legs being flexed under them as they sit up in bed. When the child is able to crawl or stand with help, it will want a great deal of looking after and amusing if deformities are to be prevented. In the milder cases seen in private practice the deformities are not usually so severe as those of the hospital class.

While splints and cutting operations belong to the domain of the surgeon, and are often required in severe deformities, a good deal can

be done in the milder and early cases, while the bones are still soft, to correct the deformities by manipulation and to strengthen the muscles and ligaments by massage and baths. Osteotomies are chiefly of value in the later stage when the bones have become hard; if performed too soon, there is danger of relapse if great care is not taken to keep the child off its feet for many months after the operation.

Rictus Lupinus.—Cleft palate (*q.v.* under PALATE).

Rideal's Method.—A chemical method of rendering water, suspected of being infected with typhoid germs, innocuous; it consists in the addition of hypochlorite of lime, permanganate of potash, and tablets of sodium bisulphate to the water.

Rider's Bone.—A sesamoid bone occasionally developed in the adductor muscle of the leg, from prolonged pressure against the saddle. *See* GROIN (*Diseases of the Groin*).

Ridge.—An elongated elevation or crest, as the genital ridge in Embryology and the occipital ridge in Anatomy.

Ridge's Food. *See* INFANT FEEDING (*Proprietary Foods, Farinaceous*).

Riedel's Lobe or Process.—A tongue-shaped process of the liver occasionally met with, lying external to the gall-bladder. *See* LIVER, DISEASES OF (*Anatomical Abnormalities, Tongue-like Lobes*).

Riga's Disease.—A malady, chiefly observed in Italy, in which a pearly membrane develops under the tongue, usually of an infant, and is associated with induration and often with ulceration of the floor of the mouth; it may be an epidemic affection.

Rigg's Disease.—Pyorrhœa alveolaris. *See* MOUTH, INJURIES AND DISEASES OF THE JAW (*Inflammatory Diseases of the Jaw*).

Rigidity. *See* BRAIN, AFFECTIONS OF BLOOD-VESSELS (*Œdema, Symptoms*); BRAIN, AFFECTIONS OF BLOOD-VESSELS (*Paralysis from Vascular Lesions with Rigidity*); JOINTS, DISEASES OF (*Impaired Mobility*); LABOUR, PRECIPITATE AND PROLONGED (*Faults in the Soft Passages*); LABOUR, INJURIES TO THE GENERATIVE ORGANS (*Laceration of the Cervix Uteri, Causation; Injuries to the Perineum, Causes*); PARALYSIS (*Cerebral Diplegia*, etc.); PREGNANCY, INTRA-UTERINE DISEASES AND DEATH OF THE FŒTUS (*Cadaveric Rigidity*).

Rigor.—A chill or shivering fit ushering in an attack of fever. *See* BRAIN, SURGERY OF (*Cerebral Abscess, Symptoms*); CATHETERS, USES AND DANGERS (*Septic Poisoning, Rigors*); KIDNEY, SURGICAL AFFECTIONS OF (*Pyelitis*); LIVER, TROPICAL ABSCESS (*Constitutional Symptoms*); LUNG, TUBERCULOSIS OF (*Constitutional Symptoms, Pyrexia*); MALARIA (*Clinical Manifestations*); PANCREAS, DISEASES OF (*Pancreatitis, Symptoms*); PNEUMONIA, CLINICAL (*Clinical Features*); PROSTATE GLAND (*Hypertrophy, Symptoms*); TYPHOID FEVER (*Symptoms, Rigors*).

Rigor Mortis. *See* DEATH, SIGNS OF (*Cadaveric Rigidity*); MEDICINE, FORENSIC (*Signs of Death, Rigor Mortis*); PHYSIOLOGY, TISSUES (*Muscle, Death of*); POST-MORTEM METHODS (*External Examination, Rigor Mortis*); CHOLERA, EPIDEMIC (*Morbid Anatomy*).

Rima.—A fissure or narrow opening, *e.g. rima glottidis* (the upper opening of the larynx).

Rinderpest.—Cattle plague. *See* IMMUNITY (*Immune Serum in Rinderpest*).

Ring.—In Anatomy the word *ring* is used as the name of a circular opening; *e.g.* the *inguinal ring, umbilical ring*, etc.

Ring, Bandl's.—The ring of contraction in the uterine wall marking the line of demarcation between the upper active uterine segment and the lower passive segment; both segments are believed to belong to the corpus uteri. *See* LABOUR, PRECIPITATE AND PROLONGED (*Obstructed Labour, Bandl's Ring*).

Ring Bodies.—Ring-shaped bodies found in erythrocytes, and perhaps representing the remains of nuclei; they are seen in severe anæmias (*e.g.* in pernicious anæmia, in that which follows sepsis, etc.).

Ring, Müller's.—The ring of contraction which in pregnancy marks the upper boundary of the cervical canal of the uterus.

Ring Pessary. *See* UTERUS, DISPLACEMENTS OF (*Descent, Treatment*).

Ringer's Solution. *See* PHYSIOLOGY, CIRCULATION (*Nature of Cardiac Contraction*).

Ringworm. *See* SKIN, PARASITES (*Tinea Tonsurans*); SKIN DISEASES OF THE TROPICS (*Craw-Craw, Dhobie Itch*); NAILS, AFFECTIONS OF THE (*Parasitic Diseases, Onychomycosis*).

Rinné's Test. *See* EAR, EXAMINATION OF (*Hearing Tests, Tuning Fork*); EAR, MIDDLE, CHRONIC NON-SUPPURATIVE DISEASE (*Tests for distinguishing Middle from Internal Ear Disease*).

Riolan's Bouquet.—The mass of muscles and tendons attached to the styloid process (styloglossus, stylohyoid, stylopharyngeus).

Riolan's Muscle.—Part of the orbicularis palpebrarum muscle.

Ripault's Sign. — A sign of death, consisting of a permanent change in the shape of the pupil produced by pressure on the eye.

Rippoldsau. *See* Balneology (*Germany, Chalybeate*).

Risorius.—The name given to one of the muscles of the face, a continuation of the platysma myoides, which draws the lips outwards, as in the act of smiling (Lat. *ridere*, to laugh); musculus risorius Santorini.

Risus Sardonicus.—The peculiar grin or distortion of the facial muscles seen in tetanus. *See* Abdomen, Clinical Investigation of (*Examination of Patient, Risus Sardonicus*); Spasm (*Hysterical*); Tetanus (*Clinical Features*).

Ritter's Disease.—Dermatitis exfoliativa neonatorum. *See* Newborn Infant (*Dermatitis Exfoliativa*).

Ritter's Law.—The law of contraction expressed in the fact that a nerve is stimulated both at the closing and at the opening of the electric current.

Ritter-Valli's Law.—The fact that division of a nerve from its centre is followed by temporary increase of irritability, followed by a gradual loss taking place centrifugally.

Ritthausen's Process.—A chemical method of estimating the proteids of milk (casein and lactalbumin).

Riverside. *See* Therapeutics, Health Resorts (*America*).

Riviera. *See* Therapeutics, Health Resorts (*Riviera*).

Rivinus, Ducts of.—The ducts of the sublingual gland. *See* Salivary Glands.

Rivinus, Notch of.—A notch in the upper margin of the annulus tympanicus, bridged over by Shrapnell's membrane.

Rivolta's Disease. *See* Actinomycosis.

Roasting. *See* Invalid Feeding (*General Preparation of Food*).

Robert's Pelvis.—The transversely contracted pelvis, or double oblique contraction of the pelvis, named after H. L. F. Robert (1814-78), who first described such a pelvis at Würzburg in 1842.

Robertson Pupil. *See* Argyll-Robertson Phenomenon.

Roborat.—A food prepared from maize; it contains lecithin and glycerinophosphoric acid.

Rochelle Salt.—The tartrate of potassium and sodium, $KNaC_4H_4O_6$, $4H_2O$.

Rock Fever. *See* Undulant Fever.

Rod and Cone Layer. *See* Retina and Optic Nerve (*Anatomy*); Physiology, Neuro-Muscular Mechanism (*Anatomy of Eye*).

Rod Test. *See* Strabismus (*Variable Squint, Maddox Rod Test*).

Rodent Ulcer.

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Rodent ulcer is the term commonly but rather unfortunately applied to a little-malignant variety of carcinoma, which is characterised by certain peculiarities. It was first described in the early part of last century by Jacobs, of Dublin, an ophthalmic surgeon, whose attention was drawn to it from the fact that it so frequently occurred in the neighbourhood of the eye. While it has been observed on almost every part of the surface, it is most common upon the upper part of the face, and indeed the great majority of cases are further limited to two situations—the angle of the nose where it rises from the face, and the outer angle of the eye. The former of these is affected probably twice as often as the latter.

It is often stated to be a disease of late life, but that statement will not stand critical examination. The statistics from which it is derived are taken from hospital reports, which give the age of the patient at the date of operation, and ignore the fact that the disease may have lasted for ten, fifteen, or more years. It has been seen in patients as young as fourteen, but its earliest signs are perhaps oftenest observed between thirty-five and forty-five. It commences as a small nodule *below* the surface of the skin, and has usually an existence of many years in this form before the ulceration, which the name leads one to expect, appears; then the centre sloughs away, and the typical rodent ulcer is developed. The surface is flat, and the ulcer terminates in the abrupt, raised, rounded, or "rolled" edge which is so characteristic of the disease. It is due to the presence beneath the skin of cancerous alveoli, which elevate and stretch the skin over them. To this stretching is due the shiny, polished appearance which the rodent edge invariably has. If left alone the disease steadily progresses, attacking everything it meets, eventually eroding the bones of the skull, and thus leading to death, but in spite of its local malignancy metastasis is practically unknown. During the whole of

its course, unless it should attack sensitive structures, the patient rarely complains of any pain. Itching, however, is usually a prominent and early symptom.

In its early stages, if the parts are kept clean the ulcer may heal up, and then a very characteristic appearance is presented, which has been compared to a flat valley surrounded by ridges of hills. The patient often congratulates himself that the disease has disappeared, but the improvement is a misleading one, for the growth continues to extend under the surface.

The origin of the disease has been the subject of much acrimonious discussion, some maintaining that it developed from the hair follicles, and others that it arose from the sweat or sebaceous glands. In the architecture of the growths there is often a suggestion of one or other of these origins; one form may have a tubular appearance, and thus suggest the sweat gland, another may spread in an acinous manner like the sebaceous one, while in some the close packing of the cells suggests the "whorled" appearance often seen in the hair follicles. Most of the observations have been made on cases of considerable standing. If the tumours are removed in the pre-ulcerative state, or better still, if moles are removed before there is any question of their being malignant, all the various forms may be found. In a chance collection of moles all the varieties of architecture seen in rodent ulcer may be observed. One form is tubular, another acinous; in another the cells are arranged in an alveolar manner; indeed it is, without a knowledge of the history, often impossible to say whether a particular specimen is a mole or a rodent.

Moles are really collections of epithelial cells which have become detached from the surface epidermis, and in most cases maintain a purely vegetative existence. If specimens are taken from infants or young children their development from the surface epithelium may be readily studied; and it is probable that Sir Benjamin Brodie's clinical observation made long ago, that rodent ulcer developed from an irritated mole, is the correct one.

Diagnosis.—In the pre-ulcerative stage, where it resembles a mole, there are no points of distinction from that except the fact that it is increasing in size, and the removal of moles in the suspicious situations is always desirable. When ulceration has set in it may be confounded with syphilitic or tuberculous ulceration, both of which are frequently seen on the face. From the former it should be easily distinguished by its relative slowness of growth; for a syphilitic ulcer will attain in a week or two a size which it would take a rodent months to reach.

From a tuberculous ulcer the diagnosis is not so easy. While tubercle is essentially a disease of youth and rodent of middle age, exceptions occur in both cases. The tuberculous ulcer, however, lacks the characteristic edge of rodent, and the rodent ulcer the apple-jelly nodules of lupus.

Prognosis.—The prognosis, unless treatment is efficacious, is extremely grave, for although the progress is slow it is steadily onwards.

Treatment. — Moles may be destroyed by electrolysis. Like all caustic methods, electrolysis has it risks, for if the destruction is not absolute the irritation may result in stimulating the disease to fresh activity. The real treatment consists in early recognition and complete removal by the knife. The majority of cases of recurrence are due to the conservatism of the surgeon, who is anxious to destroy the patient's appearance as little as possible. The incision must be quite clear of the edge laterally, and the entire thickness of the skin must be removed. Some years ago the writer received a most instructive lesson. A small rodent about the size of a silver penny was removed from the face of a lady. Next day examination of the specimen showed that the knife had divided one cancerous globule. A further portion of the skin was therefore forthwith removed, and in it was found the other half. Had the examination not been made it would have been written down as another case of recurrence, whereas the fact was that the disease had not been removed. The patient was the wife of a medical man, who reports that now, six years after the operation, there has been no recurrence. When the ulcer has reached the size of a shilling the scar left by removal is often unsightly, and in such cases the method strongly recommended by so many American dermatologists, and by Unna, and Czerny, of destroying the growth by means of arsenious acid may be adopted. It must be explained to the patient that the pain is very great, and while means may be taken to modify it, the method is inapplicable in weak, nervous patients. Equal parts of arsenious acid and acacia powder are made into a paste with a little water, and applied to the part. If the skin over the edges is thick it should be curetted, or as some recommend, be painted with liq. potassæ, which dissolves the epidermis. The duration of application depends on the extent of destruction which is necessary. Arsenic has some of the selective action which salicylic acid has on lupus; it destroys the cancerous tissue, while only inflaming what is healthy. When the destruction has been sufficient, poultices may be applied to hasten the separation of the slough and encourage the granulations to fill up the loss of tissue. This method thoroughly carried out is justifiable in certain cases, but there is no doubt that the knife, in capable hands, is a more certain method of treatment.

Perhaps one of the most wonderful of all the properties of the X-rays is their effect upon this

disease. Discovered more or less accidentally by Sequeira, their use has spread, and the benefit resulting from their use is everywhere acknowledged. Exposures of ten minutes daily at a distance of four inches will often destroy a rodent the size of a shilling in six or eight weeks, with a resultant scar which leaves nothing to be desired in appearance. Even cases which have spread beyond the reach of the surgeon's knife cicatrise in a perfectly wonderful manner. The X-ray apparatus, however, is not in every one's hands, and thorough excision still remains the most dependable treatment for rodent ulcer.

Roe. *See* Invalid Feeding (*Fish, Roe*).

Roe Bodies. *See* Mycetoma (*Pathology*).

Roederer's Obliquity. — The fact that at the beginning of labour the fœtal head lies at the brim of the mother's pelvis with its occipital end lower than its sincipital; commencing flexion. *See* Labour, Diagnosis and Mechanism (*Presentations of the Vertex*).

Roentgen or Röntgen Rays. *See* X-Rays. *See also* Eyeball, Injuries of (*Removal of Foreign Bodies*); Lung, Tuberculosis of (*Diagnosis, Röntgen-ray Illumination*); Nails, Affections of the (*Injuries, Röntgen Rays*); Osteo-Arthropathies (*Diagnosis*); Sclerotic, Diseases of (*Injuries*); Teeth (*Exostosis, Diagnosis*).

Roger's Disease.—Congenital malformation of the heart, consisting in the presence of a perforation in the interventricular septum.

Roger's Symptom.—The presence of a subnormal temperature in the third stage of tubercular meningitis.

Rokitansky's Disease.—Acute yellow atrophy of the liver.

Rolando, Fissure of. *See* Brain, Physiology (*Cerebral Cortex*); Physiology, Cerebrum (*Cortical Centres, Rolandic Area*).

Roller Bandage. *See* Bandages (*Varieties*).

Rollet's Stroma.—The insoluble network supposed to constitute the sustentacular part of a red blood corpuscle.

Romberg's Disease.—Progressive facial hemiatrophy.

Romberg's Sign. — The swaying of the body when the eyes are closed and the feet placed together; it is characteristic of *tabes dorsalis* (*q.v.*) and of hereditary cerebellar ataxia.

Romberg's Spasm.—Trismus, or the masticatory spasm of Romberg, seen in affections of the fifth nerve. *See* Fifth Nerve (*Spasm of Muscles of Mastication*).

Roncegno. *See* Balneology (*Austria, Chalybeate*).

Röntgen Rays. *See* X-Rays; Rontgen Rays and *Cross References*.

Roof Nucleus. — The nucleus fastigii. *See* Physiology, Cerebellum (*Structure*).

Rosacea. *See* Acne; Skin Diseases of Sweat and Sebaceous Glands (*Rosacea, Treatment*).

Rosæ Gallicæ Petala. — Red rose petals are got from *Rosa gallica*, and contain a volatile oil (*q.v.*), with some tannic and gallic acid; there are three official preparations: *Confectio Rosæ Gallicæ* (dose, 30-60 gr.), *Infusum Rosæ Acidum* (dose, ½ to 1 fl. oz.) which contains sulphuric acid, and *Syrupus Rosæ* (dose, ½ to 1 fl. dr.). *Oleum Rosæ*, the oil or otto of rose, is obtained, not from *Rosa gallica*, but from *Rosa damascena*; it contains geraniol ($C_{10}H_{18}O$), an alcohol; and it has two official preparations: *Aqua Rosæ* (dose, 1-2 fl. oz.), and *Unguentum Aquæ Rosæ* or Cold Cream. The preparations of rose are employed, not so much for their own medicinal properties, but rather as vehicles for other drugs more active and less pleasant.

Rosaniline. *See* Urine, Pathological Changes in (*Drugs*).

Rosary, Rachitic. *See* Rickets (*Clinical Features, Chest*).

Rose Cold.—A form of hay fever; June cold. *See* Hay Fever.

Rosenbach's Disease. *See* Heberden's Nodes.

Rosenbach's Sign. — Loss of contraction of the abdominal muscles in inflammatory disease of the intestines; also tremor of the eyelids when the attempt is made to close them, as seen in neurasthenia.

Rosenmüller, Organ of. — The parovarium. *See* Broad Ligaments; Generation, Female Organs of (*Organ of Rosenmüller*).

Rosenthal's Canal. — The canalis spiralis modioli of the cochlea, containing the ganglion of Corti.

Roseola. *See* Rubella.

Roserash. *See* Rubella.

Rose's Position. — The position in which the head hangs over the end of the table or couch; *e.g.* in operations on the respiratory passages, to prevent the passage of blood into the trachea.

Rose's Operation. *See* Nerves, Neuralgia (*Trigeminal Neuralgia, Roses Operation*).

Rosette Body.—The monaster formed in the cell during mitosis (*see* Physiology, Protoplasm, *Cell, Division by Mitosis*); also bodies found in the parasite of malaria in the sporulating stage (*see* Malaria, *Description of Parasite*).

Rosin. *See* Resina.

Rossbach's Disease. — A gastric neurosis characterised by the vomiting of very acid fluid, by headache, and by gastralgia.

Rostrum.—A beak-shaped projection (*Lat. rostrum*, a beak); *e.g.* the rostrum of the sphenoid bone, and the rostrum of the osteomalacic pelvis.

Rotation. *See* Brain, Cerebellum, Affections of (*Tumour, Disturbances of Equilibration*); Labour, Diagnosis and Mechanism (*Presentations of the Vertex, Internal and External Rotation*); Restitution.

Rotators.—Muscles which produce rotation of a limb or of the trunk, *e.g.* the *rotatores dorsi*.

Röthein. *See* Rubella. *See also* Measles (*Diagnosis*).

Rothesay. *See* Therapeutics, Health Resorts (*Scotch*).

Roth's Disease. — Meralgia paræsthetica; sensations of numbness, with hyperæsthesia, in the region of the thigh supplied by the external cutaneous nerve.

Rotorua. *See* Balneology (*New Zealand*).

Rotula.—The patella. *See* Knee-Joint, Injuries of (*Fracture and Dislocation of Patella*).

Rouleaux. *See* Blood (*Nature of Coagulation*); Physiology, Circulation (*Blood, Red Corpuscles*).

Round Ligaments. *See* Generation, Female Organs of (*Uterus, Ligaments of*); Pregnancy, Physiology of (*Changes in Peritoneum and Appendages*); Uterus, Displacements of (*Descent, Treatment by Shortening the Round Ligaments*).

Round Worms. *See* Parasites (*Nematodes, Ascaris Lumbricoides*).

Row's Test.—The bactericidal effect of plague serum upon the bacillus pestis; it is said to be useful in estimating the protective effects of treatment by Haffkine's serum.

Royat. *See* Mineral Waters (*Alkaline*).

Roy's Cardiometer. *See* Physiology, Circulation (*Work of the Heart*, Fig. 126).

Rubber Gloves. — Gloves of rubber which can be sterilised, and which are commonly used during surgical and obstetric manipulations to protect the wound from septic materials, or the hands from contamination by the discharges of a septic wound or surface.

Rubefacient.—Causing redness of the skin; *e.g.* all drugs which cause this phenomenon by dilating the cutaneous vessels (*e.g.* ammonia, mustard, camphor, etc.) are called *rubefacients*. *See* Pharmacology.

Rubella: Roserash.

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Nomenclature. — Roseola, epidemic rossalia, epidemic roseola, roséole épidémique, roserash; rubeola, rubeola notha, rubeola sine catarrho, rubéole, rougeole, false measles; Rötheln, German measles.

Definition.—A definite and distinct zymotic disease, very infectious, and occurring usually in epidemic form in the spring of the year. It mainly affects adolescents and young adults of both sexes. It affords no protection against measles, scarlet fever, or "the Fourth disease," but protects against itself. The period of incubation is a fortnight or more. The disease is infectious even prior to the appearance of the rash, which is usually the first noticeable symptom; and its duration of infectiveness is about a fortnight. It produces no mortality or sequelæ in this country.

Geographical Range.—The disease occurs in the British Isles, on the continent of Europe, and it is known also in Egypt, India, and America.

History.—No cases in medicine are, at times, more perplexing, and involve the expenditure of greater thought and judgment than zymotic diseases. Their elucidation has bewildered and misled many of the ablest and most experienced physicians.

The disease now to be considered is perhaps

the most difficult in these respects, and even now its character as a distinct disease is sometimes denied. It seems to have been known to the Arabian physicians under the name of hhamikah. Little, however, is recorded of its existence until the *early part* of the eighteenth century, when it was known by the name of Roseola; the term Epidemic Rossalia was subsequently applied. The record of the disease, however, was slight until the *middle* of the eighteenth century (1758), when the Germans described it under the name of Rubeola. In the middle of the nineteenth century it reappeared in German medical literature under the name of Rotheln, which we, unfortunately, have translated by the popular name of German Measles.

Scarcely any term, I think, in medical language has created so much perplexity and obscurity as the word measles; for it involves inconceivable difficulty through the confusion under one name of four distinct diseases: Roserash, Measles, Scarlet Fever, and what I have termed provisionally a Fourth Disease.

This uncertainty has no doubt partially arisen from the vagaries of the disease itself; and partially also from inherent difficulties in diagnosis, by reason of its close resemblance to measles; but undoubtedly the principal cause has been an erroneous nomenclature, with the result that English measles is confounded with German measles.

It was not until the close of the seventeenth century that, mainly through the researches of Sydenham, scarlet fever was differentiated from measles; and at the end of the nineteenth century roserash is still confounded with measles, with scarlet fever, and with the fourth disease. Yet the difficulties are not greater than the differences between typhus and typhoid fevers —a problem ably solved by Jenner in the middle of last century (1849-50) with beneficial results.

These four diseases are not varieties of the same species, but are perfectly distinct and definite diseases, notwithstanding the obscuring resemblances which may sometimes appear in "certain" characteristic features.

A fundamental law in medicine—the science of our practice enforced by Cullen more than a century ago, but now too frequently ignored —is, that one attack of an eruptive fever entails immunity from a second attack in the same individual during childhood.

The "germs" of infectious diseases apparently require a virgin soil for development; a prior attack seems to exhaust the soil, or to transform it chemically by the products of their growth in such a manner as to render it incapable of furnishing a suitable nidus for the reproduction of the germs. The law is so pervading—for the insignificant exceptions may be regarded as scientific curiosities only—that for the practical guidance of our work it may be adopted as an absolute and invariable rule.

Each disease, moreover, has its characteristic seed, entirely *sui generis*; although microphytes may bear some relation to saprophytes in their origin.

But a curious fact, at present inexplicable, in the life-history of these zymotic diseases is, that the growth of some germs in the body seems to produce so essential an alteration in the soil as to facilitate the immediate fertilisation and development of the germs of other diseases. For example, the concurrence, or sequence, of measles and whooping-cough, of scarlet fever and diphtheria, and of measles and diphtheria, is well recognised.

Etiology.—(i.) *Predisposing Causes.*—1. Age. —Some authors assert that the disease is most prevalent in young children. In my experience, on the contrary, the sufferers are usually adolescents and adults. I have very rarely observed the disease in infants, or in children in the nursery; only occasionally in private schools, where the ages range from nine to thirteen years; and when it occurs at the public school age, thirteen to nineteen years, the elder rather than the younger boys have been attacked. After searching my record of one hundred new boys, taken consecutively, I find that twenty-eight have had, and seventy-two have not had this disease before their entrance to Rugby School at the age from thirteen to fourteen years.

2. Sex.—Each sex is equally liable.

3. Season.—The disease appertains to spring and early summer; out of 275 cases which I tabulated in 1896, all but four occurred between March and July. And it becomes epidemic every five or six years.

(ii.) *Exciting Causes.* — 1. Contagion. — Rubella is one of the acute infectious diseases depending upon a specific virus arising from germs which, so far as I am aware, have not yet been isolated.

2. Mode of Communication.—The channel of extension is personal intercourse, and, when once started in a susceptible community, the disease spreads as rapidly and widely as measles —if, indeed, its speed and range be not greater. My experience is that even if isolation be adopted on mere suspicion, and without waiting for definite evidence, the disease will spread.

Varieties.—Until the year 1900, from want of actual proof to the contrary, I believed that there were simply two varieties of this disease: one in which the eruption resembled that of measles, the other in which it simulated scarlet fever. But I am now convinced that only one form exists, namely, that in which the eruption is of the measles type; while the scarlet fever variety is a distinct disease, which I have provisionally termed a "Fourth disease."

Abortive cases are frequent, and are re-

sponsible to a large extent for the spread of this disease. The difficulty is one of definite detection, as no actual illness takes place.

1. Pink Eyes.—A group of cases of roserash occurs which have no symptoms that I have yet ascertained, except *pink conjunctivæ*. And these cases, while capable of transmitting the illness to others, provide immunity against a subsequent personal attack.

2. Another group of cases of roserash may, I believe, occur (but I cannot, at present, advance beyond belief, as I have not yet satisfied myself by actual proof), without showing any symptoms beyond slight feverishness and *enlargement of the lymphatic glands*, particularly the post-cervical, the axillary, and the inguinal.

Symptomatology. — (i.) *Premonitory Symptoms.*—In many instances none are discoverable — neither headache, vomiting, catarrh, nor cough, though some amount of sore throat usually exists. If the attack be severe there may be some malaise, anorexia, and drowsiness.

(ii.) *Sensations of Illness.* — Even where a very full eruption occurs, as intense as in a typical case of measles, the patient usually states that he does not feel ill, although other indications to the contrary may be visible. While in measles, I have heard the most vigorous declare that they never felt so ill in any previous illness.

(iii.) *The Temperature.*—The variation ranges from normal to 103° Fahr. or even 104° Fahr. In the latter case the temperature, in my judgment, arises from idiosyncrasy.

(iv.) *The Pulse.*—The pulse is normal, or may be increased in frequency; it always bears, however, a ratio to the temperature.

(v.) *The Tongue.*—The tongue is clean, or slightly furred. It is never coated with a thick white fur, and never peels.

(vi.) *The Throat.*—The fauces are dry in appearance, of a motley red hue, much resembling the eruption on the skin. This condition of the pharynx may occasion some amount of cough.

(vii.) *The Glands.*—The lymphatic glands throughout the body are enlarged, tender, and hard like peas—notably the posterior cervical, the axillary, and the inguinal. But they never suppurate.

(viii.) *The Eyes.*—The eyes are generally pink red and suffused.

(ix.) *The Eruption.* — The first noticeable symptom is usually the eruption.

Its appearance, *at first*, is that of minute *rosy red* dots raised somewhat from the surface of the skin, but not patches. It is first visible behind the ears, on the scalp, and on the face, especially on the oral circle. From these situations it extends to the neck and chest, and ultimately may cover diffusely, or in patches, the entire body. The minute dots become larger and gradually coalesce, forming patches of the bat's wing pattern, which so extend and alter in colour as to be indistinguishable from the rash of measles.

In other cases the spots become so diffused that the rash, in patches, resembles the rash of scarlet fever; but in this disease the diffuse scarlet fever looking rash never manifests itself from the commencement.

The eruption lasts from one to five days, according to the nature of the attack, and first fades where it first appeared. Itching of the skin occasionally occurs, as it is apt to do in all cases when hyperæmia of the skin is present.

It is evident that, in diagnosis, the eruption must not be relied on, but a consideration of the collateral symptoms is imperative.

(x.) *Desquamation.*—There may, perhaps, be a little brawny desquamation; but frequently, or rather usually, none occurs.

(xi.) *Albuminuria.* — Where albuminuria is found it is, I believe, that form only which is incidental to adolescents.

Stages.—(1) *The Period of Incubation.*—By this is meant the interval between exposure and the manifestation of symptoms. The first noticeable symptom in all ordinary cases of this disease is the rash, and it is from this epoch—from rash to rash—that the period of incubation can alone be calculated. It must, however, be borne in mind that the disease is undoubtedly infectious prior to the exhibition of any symptoms which the minutest scrutiny can discover.

In investigating the period of incubation of infectious diseases generally, it is essential that every case should be instantly removed on its occurrence from the house to hospital, and no communication whatever should be permitted between the sick and the healthy. Any less stringent mode of isolation is absolutely fallacious and inoperative. The period also can only be calculated from well-marked isolated cases; or from the beginning and termination of epidemics, when the cases occur slowly. An attempt to measure the incubation period during the height of an epidemic when many are succumbing daily, or to calculate it when the disease is epidemic in towns, is entirely futile. I desire to emphasise this statement, because the incubation period of this ailment is so diversely assigned. One of the leading epidemiologists, for instance, knowing my deep interest in the question of incubation, informed me some years ago that he had found an instance where the term was barely twenty-four hours, because he showed a case one afternoon to a young medical man who desired to see the eruption, and on the succeeding day the young practitioner himself was attacked with roserash. I pointed out to him, however, that the disease was exceedingly rife in London at the time;

that his friend was travelling daily; and that no more infectious places existed, outside infectious hospitals, than railway carriages, trams, cabs, and churches, which are rarely ventilated during or after the services. Rubella is unquestionably one of the infectious ailments which involve a long period of incubation. And when an observer appears to find an incubation period of less than twelve days, he should, in his own mind at all events, doubt the supposed fact. The most common period is the eighteenth day; but it may range from twelve to twenty-two days, and accordingly, when a term of five days is alleged, the true period will probably be 5 + 12 days.

(ii.) *The Period of Infection.*—It is needful to repeat that, although in most cases the first detected symptom is the rash, the disease is infectious at a prior stage, for even when I have isolated on mere suspicion the disease has still spread. I am not prepared to specify definitely the length of this earlier stage; but a minimum of forty-eight hours may be fairly accepted. The extent of infectiousness after this period I am not able to assign, since all my cases being isolated in hospital, the possibility of infection has ceased. I think, however, we may reasonably assume that the disease is highly infectious until the rash attains its height, and that it gradually wanes as this fades and the brawny desquamation ceases.

My plan at Rugby is—

1. In very mild cases to isolate for ten days;
2. In the average case for fourteen days;
3. And in a severe case, followed by much desquamation, to allow a few days beyond the fourteen.

In all instances disinfecting baths are given on several nights, and the clothes are disinfected as carefully as in scarlet fever.

This plan has never failed me in an experience of thirty-one years; but it may be that even these periods of isolation are longer than is absolutely necessary.

Owing to the completeness of the system of isolation and disinfection just described, which should be the plan to be aimed at in all infectious diseases, I possess no evidence relating to the retention of infection in clothes.

(iii.) *The Period of Protection.*—In my judgment there is absolute immunity from a second attack; and I believe that any contrary statement arises from confusing this disease with the "Fourth disease," or with English measles.

The disease affords no protection against English measles, scarlet fever, or the Fourth disease.

Sequelæ.—There are practically no sequelæ, though I have seen the submaxillary glands enlarged. Inasmuch, however, as the slightest feverish attack, for example from a cold, or even vaccination, may in the delicate or cachectic develop latent mischief, and may be answerable for a considerable deterioration of health, so this slight feverish zymotic disease may similarly act. But there are literally no sequelæ pathognomonic of it.

Relapse.—I have never seen a case of relapse or recrudescence, although these are stated to occur occasionally.

Relation to other Diseases.—The disease is of frequent occurrence in those who have had measles a short time previously, and *vice versa*, so that these two diseases are mutually unprotective. And when the disease breaks out in a community, where some have had measles and some not, it attacks them indiscriminately, and never develops into true measles.

Diagnosis.—(i.) *Measles.*—Some cases of this disease so accurately resemble measles in the eruption that, at a certain stage of the illness, it is impossible to distinguish between them. The temperature, the pulse, and the eruption are frequently almost identical—the differences varying merely in degree. The distinctions, therefore, between a severe case of roserash and a mild case of measles will puzzle the most wary. It is only by seeing the disease from the commencement, or by studying a group of cases and obtaining an accurate history, that a valid diagnosis can be effected. This difficulty mainly arises from the fact that the diagnosis is apt to be based on the appearance of the eruption alone, without the devotion of sufficient attention to the history of the attack, the incubation period, and the presence or absence of other symptoms.

Those alone who are connected with the treatment of the young when congregated in large numbers realise the difficulty and doubt produced by classing two perfectly distinct and definite diseases under the common name of measles without the prefix of "English" or "German." This confusion may be largely rectified by calling "English measles" (Morbilli) measles, pure and simple, and designating German measles (Rubella) roserash. At present when a pupil is certified as having had "measles" it frequently means that he has had the German variety, and *vice versa*, and thus he starts an epidemic amongst those supposed to be protected by a previous attack.

The prodromata of measles with three days' malaise, catarrh, and cough accompanied by fever are quite pathognomonic of measles. The eruption, not appearing until the fourth day of measles, instead of the first as in roserash, is, however, quite convincing. The glandular hypertrophy is absent in the early stage of measles. And the period of incubation is usually of much shorter duration in measles.

Sequelæ are frequent in measles and often formidable, while they are absent in roserash.

(ii.) *The Fourth Disease.*[1]—Until April 1900,

[1] "On the Confusion of two different Diseases under the Name of Rubella," Clement Dukes, *Lancet*, 14th July 1901; "Fourth Disease," J. J. Weaver, *The Journal of State Medicine*, 1901.

when I was able finally to prove what I had long suspected, I had, with the profession generally, confused two diseases under the head of rubella. I concluded that there were two varieties of this disease: the one showing a rash resembling that of measles, the other almost identical in appearance with scarlet fever. It is quite clear, however, that these are not varieties of the same disease, but two distinct diseases, neither of them protecting against the other. For in a series of cases of the "Fourth disease" 42·1 per cent had already suffered from roserash (*see also* "SCARLET FEVER").

(iii.) *Roseola Simplex.*—This eruption also, which arises in hot weather after chill, or as the product of various indigestible articles of diet, closely resembles roserash. It is, however, distinguished by the absence of fever, as well as by the absence of enlargement of the lymphatic glands.

(iv.) *Caterpillar Rash.*—During the season when roserash is rife, as I pointed out in the *Lancet* in 1881, boys are very fond of keeping caterpillars, some species of which occasion a rash and a redness of the eyes which closely resembles the signs of roserash at its commencement, and may involve considerable difficulty in diagnosis during the middle or the beginning of a roserash epidemic. The only safe plan is isolation for twenty-four hours.

The chief creatures which occasion this rash are:—the oak-eggar or Bombyx quercus, the Liparis auriflua, the Arctia caja, and Arctia villica, and the common drinker or Odonestris potatoria. On the part of the body on which they crawl, or which is touched by the fingers that have handled them or cleaned out their cages, a measly rash appears. As a rule it commences on the fingers; these rub the eyes, and typical measly-looking eyes are presented. Then the face or neck is scratched; or, if in cricket-clothes, any part of the body, and then ensues a subcuticular or a measly-looking rash. So common is this occurrence in early summer that in making a diagnosis this possible origin is always in my mind.

(v.) *Flower Rash.*—The eruption arising from handling the Primula obconica also closely resembles the rash in its early stage.

(vi.) *Drug Rash.*—Some drugs may also create a difficulty when they are administered, as they produce a very similar eruption, such as the bromide rash, or the copaiba rash.

PROGNOSIS.—The prognosis is favourable, as the ailment is the simplest of the zymotic diseases. Under the head of "Sequelæ" I have pointed out the cases where even this mild illness may cause anxiety.

TREATMENT.—(i.) *Isolation.*—All cases of infectious illness should be isolated, and, where possible, in a separate house or hospital. Even this slight illness should be included in the rule, since it is not necessary that all should suffer from it, and it is exceedingly inconvenient and unpleasant when large numbers are simultaneously attacked, even although the illness may neither be severe nor fatal. Isolation should be enforced, whenever possible, before the appearance of the eruption if the epidemic is to be kept under control. The difficulty is that so many fall without any palpable previous symptom. Still, during an epidemic, when the young look heavy and are not quite themselves, the time has arrived for isolation.

(ii.) *Prophylactic.*—When the patient has been isolated, the question arises as to the requisite treatment for a safe and speedy cure, and the earliest possible release.

My invariable custom in average cases is to keep the patient in bed for five days, to get him up for three days, and to send him out for six days. During these latter days he has a bath every night, and on the fifteenth day his clothes are passed through the disinfecting chamber. He is then safe, even if some desquamation continues, to mingle with his friends. In mild cases a few days less are assigned; and in more severe cases, or in the delicate, a few days more.

(iii.) *Dietetic.*—During the fever-period a milk and farinaceous diet, with plenty of water to drink, is essential. As the fever subsides soups, eggs, and fish; and after a day or two the ordinary diet may be allowed—bearing in mind, however, that in children and adolescents the appetite is enormous, and may be satisfied, since growth proceeds even during illness.

(iv.) *Curative.*—Nothing is necessary beyond the ordinary rules of treatment for slight febrile ailments unattended by complications.

(v.) *Convalescents.*—In respect of the period of convalescence of the young I desire to add a word on their behalf. Time passes wearily with them during isolation from their friends. They cannot always be reading, nor is this beneficial; but they do need in-door games and out-door games as conducive to a happy restoration to health.

Rubeola. *See* MEASLES (*Synonyms*).

Rubidium.—Rubidium, an element (Rb) with the atomic weight 84·8; the iodide and the bromide have been used in medicine instead of the corresponding potassium salts.

Rubinat. *See* BALNEOLOGY (*Spain and Portugal, Sulphated Waters*).

Rue.—*Oleum Rutae*, or oil of rue, the volatile oil of *Ruta graveolens*, is no longer officinal in the B.P.; it was formerly employed externally as a rubefacient, and internally (dose, 2 to 5 m.) as a carminative, antispasmodic, and especially as an emmenagogue.

Ruffini Eudorgans.—Special terminal nerve corpuscles found especially in the skin of the finger-tips.

Ruga.—A fold or ridge, *e.g.* of the mucous membrane of the vaginal canal.

Rum. *See* Alcohol (*Spirits*).

Rumination. *See* Indigestion (*Symptoms, Motor, Rumination or Merycism*); Stomach and Duodenum, Diseases of (*Symptomatology of Gastric Neurosis, Perversions of Motility*).

Rupia. *See* Syphilis (*Tertiary, Skin Eruptions*); Bromism (*Cutaneous System*).

Rupture.—Tearing or laceration of an organ (hollow or solid); also hernia. *See* Ear, Affections of Tympanic Membrane (*Injuries*); Labour, Faults in the Passenger (*Membranes, Cord, Hydrocephalus*); Labour, Accidental Complications (*Rupture of Cord*); Labour, Post-Partum Hæmorrhage (*Traumatic*); Labour, Injuries to the Generative Organs (*Rupture of Uterus, Cervix, Vagina, Perineum*); Medicine, Forensic (*Various Kinds of Injuries, Ruptures of Internal Organs*); Muscles, Diseases of the (*Rupture of Muscle*); Muscles, Traumatic Affections of (*Rupture*); Œsophagus, Injuries and Diseases of (*Wounds and Ruptures*).

Russell's Bodies.—Bodies found in cancer cells, hyaline or colloid in character; fuchsin bodies.

Russia. *See* Balneology (*Vapour Baths, Russian Spas*).

Rust's Disease.—Tuberculous spondylitis of the upper cervical vertebræ.

Rut. *See* Menstruation (*Relation to Œstrus*); Œstrus.

Ruysch's Membrane.—The lamina chorio-capillaris of the eye.

Rye. *See* Ergot and *Cross References.*

S.—S. is used as a contraction for *signetur* (let it be labelled) in prescription-writing, also for *sinister* (left) and for *sacro* in the names of the positions of podalic lies (*e.g.* L.S.A., left sacro-anterior position).

Sabadin.—An alkaloid ($C_{29}H_{51}NO_8$) obtained from the seeds of *Schœnocaulon officinale*, acting as a sternutatory.

Sabouraud's Theory.—The theory that acne vulgaris originates in an oily seborrhœa due to a bacillus, with the formation of plugs in the sebaceous follicles. *See* Acne (*Acne Vulgaris, Pathogeny*).

Saburra.—Foulness of the stomach from decomposing substances retained in it; sordes; the Latin word *saburra* means coarse sand or ballast.

Sac.—A cavity or space in the body or in some formation, normal or abnormal, of the body, *e.g.* the amniotic sac, lachrymal sac, peritoneal sac, yolk sac, etc.

Saccade.—A French term meaning a jerk, *e.g. mouvements saccadés*, jerky movements.

Saccharated.—Made up with sugar, *e.g.* the saccharated carbonate of iron (*Ferri Carbonas Saccharatus*).

Saccharin.—Glusidum; Benzoyl-sulphonic-imide. A white, minutely crystalline powder, soluble 1 in 400 of cold water. It is derived from *toluene*, a coal-tar product. It combines with soda to form "soluble saccharin," which is freely soluble in water. *Elixir Glusidi* (B.P.C.) contains 1 gr. in 20 m. The dose of saccharin is $\frac{1}{2}$-2 gr. It is used as a sweetening agent in place of sugar by diabetic patients and by persons who are on special diet for the reduction of weight. It is excreted from the body unchanged. If given in too large doses it may aggravate or cause dyspepsia. As it is two hundred and twenty times stronger than sugar in sweetening power, only very minute quantities require to be taken. The elixir is an excellent agent for disguising the taste of nauseous drugs.

Saccharomyces. *See* Air, Examination of (*Micro-Organisms*); Micro-Organisms (*Moulds and Yeasts*).

Saccharomycosis.—A morbid condition due to yeasts or saccharomyces.

Saccharoses.—Carbohydrates isomeric with cane-sugar ($C_{12}H_{22}O_{11}$), and sometimes cane-sugar itself.

Saccharosuria.—The presence of saccharose or sucrose (cane-sugar) in the urine.

Saccharum Lactis.—Sugar of milk, or lactose ($C_{11}H_{22}O_{11}.H_2O$), is contained in several official preparations, such as the *Extractum Nucis Vomicæ* and the *Extractum Opii*; and it is often used as an addition to cow's milk in the artificial feeding of infants. *See* Infant Feeding.

Saccharum Purificatum.—Cane-sugar ($C_{12}H_{22}O_{11}$) exists as refined sugar in the B.P., and is used as a sweetening agent; there are two official preparations, the *Syrupus* and the *Syrupus Glucosi* (for making pills).

Saccule.—A small sac; also a part of the membranous labyrinth of the internal ear. *See* Physiology, Neuro-Muscular Mechanism (*Hearing, Internal Ear*).

Sacer Morbus.—Epilepsy (*q.v.*); literally, sacred disease.

Sach's Disease.—Amaurotic family

idiocy. *See* MENTAL DEFICIENCY (*Amaurotic Variety*).

Sacralgia.—Pain in the sacrum or small of the back, common in gynæcological complaints. *See* GYNÆCOLOGY, DIAGNOSIS IN (*Symptoms*).

Sacro-.—In compound words *sacro-* means relating to the sacrum; *e.g. sacro-coccygeal* (belonging to the sacrum and coccyx), *sacrodynia* (pain in the sacral region), *sacro-iliac* (belonging to the sacrum and ilium), *sacro-pubic* (belonging to the sacrum and pubic bone or region), etc. *See* HIP-JOINT, DISEASES OF (*Diagnosis of Hip Disease*); PELVIS, PERINEUM AND PELVIC FLOOR (*Sacro-pubic Hernia*).

Sacro-Lumbar Angle.—The promontory of the sacrum; the projection formed by the first sacral and the last lumbar vertebral bodies.

Sacrum. *See* FRACTURES (*Pelvis*); HEART, MYOCARDIUM AND ENDOCARDIUM (*Symptomatology, Dropsy over the Sacrum*); RECTUM, DISEASES OF (*Stricture, Symptoms*).

Sactosalpinx.—Distension of a Fallopian tube with retained secretion (serous, hæmorrhagic, or purulent) from obstruction to the lumen. *See* FALLOPIAN TUBES (*Salpingitis, Closure of Ostium and Results*).

Saffron. *See* CROCUS; TOXICOLOGY (*Abortifacients, Saffron*).

Sagittal.—Shaped like an arrow; *e.g.* the sagittal suture of the cranium, which, along with the anterior and posterior fontanelles, has the shape of an arrow.

Sago. *See* INVALID FEEDING (*Diet during Convalescence*).

Sago Spleen.—The spleen affected with amyloid degeneration is so called on account of its appearance.

Saint Anthony's Fire. *See* ERYSIPELAS.

Saint Gothard's Disease. Anchylostomiasis and resulting anæmia. *See* ANCHYLOSTOMIASIS; PARASITES (*Strongylidæ*).

Saint Martin's Evil.—Alcoholism (*q.v.*).

Saint Vitus's Dance.—Chorea (*q.v.*).

Sal.—Salt or a salt-like substance; *e.g. sal volatile* (*see* MORPHINOMANIA AND ALLIED DRUG HABITS).

Sal Alembroth.—A non-official preparation consisting of ammonio-mercuric chloride, acting as a powerful antiseptic, and used as gauze, as wool, or as a solution for the purposes of antiseptic surgery and in syphilis.

Sal Ammoniac. *See* AMMONIUM AND ITS SALTS (*Ammonium Chloride*).

Sal Volatile. *See* AMMONIUM AND ITS SALTS (*Ammonii Carbonas*).

Salaam Convulsions. *See* HEAD-SHAKING (*Clinical Features*).

Salactol.—A preparation containing the sodium salts of salicylic and lactic acids dissolved in a 1 per cent solution of hydrogen peroxide; it has been recommended, in solution, for painting the throat in diphtheria.

Salicin. *See also* RHEUMATISM (*Treatment*); PSORIASIS (*Treatment*).—A bitter, colourless, crystalline glucoside obtained from willow bark. It is soluble 1 in 30 of cold water, 1 in 1 of boiling water. *Dose*—5-20 grs. It is used as a substitute for the salicylates in acute articular and muscular rheumatism, and is spoken of very highly by some authorities. It has also been employed in chronic rheumatism and in influenza. It is best administered in cachet.

Salicylic Acid and Salicylates. *See also* ASPIRIN; DRUG ERUPTIONS (*Salicylic Acid*); PHARMACOLOGY; PURPURA (*Toxic*); RHEUMATISM, ACUTE (*Treatment*); TINNITUS AURIUM (*Causes*); TOXICOLOGY (*Salicylate of Soda*); URINE, PATHOLOGICAL CHANGES IN (*Drugs*).—ACIDUM SALICYLICUM occurs as colourless crystals or in fine white powder, odourless, and with a sweet taste. It is derived from carbolic acid, or from the natural salicylates found in plants. It is soluble 1 in 500 of water, 1 in 4 of alcohol, and 1 in 55 of chloroform. *Dose*—5-20 grs. *Preparation*—Unguentum Acidi Salicylici, 2 per cent. SODII SALICYLAS is derived from the acid. It is in the form of white scales or shining crystals, with a sweetish saline taste; soluble 1 in 1 of water, and 1 in 6 of alcohol. *Dose*—10-30 grs.

Salicylic acid is powerfully antiseptic, and is used externally for this purpose, and also as a stimulant and mild caustic. In the treatment of wounds and in the preparation of dressings it has been discarded in favour of more suitable antiseptics. It is still employed, however, for venereal sores and small burns as an ointment or dusting powder. It is of great service in some skin diseases, such as acne, seborrhœa, and eczema. Applied locally it inhibits sweating, and a powder containing salicylic acid with chalk or starch checks profuse perspiration of the feet or armpits. Corns are treated by lint soaked in a solution of the acid, or 10 per cent salicylic acid in collodion may be painted on with a brush. As an internal antiseptic, salicylic acid is of doubtful value, and is absorbed into the blood as sodium salicylate. In rheumatic conditions the *sodium salt* is almost always preferred to the acid, as it is more soluble

and less irritating to the stomach. *Sodium salicylate* is a specific for acute rheumatism. It relieves the pains, lowers the temperature, and in every way reduces the sufferings of the patient. If given in sufficiently large doses some effect is almost invariably to be noted within the first twenty-four hours. The effect on the joint pains is usually earlier and more marked than that on the temperature, but the antipyretic action is greater than can be accounted for solely by the diffuse diaphoresis produced. An average dose to start with in an adult is 20 grains every two hours, and later on the amount must be increased or diminished according to the amelioration of symptoms produced and the evidence of the establishment of a full physiological action (singing in the ears, etc.). It is better tolerated and is less irritating to the stomach if given in combination with sodium bicarbonate. After the temperature has fallen and the swelling and pain of the joints have gone the dose should be gradually diminished, but the administration must be continued for about ten days after the acute attack on account of the tendency to relapse. Cardiac and other sequelæ of rheumatic fever are less frequent when the disease has been treated by salicylates. When nervous symptoms are prominent, and occasionally in other cases, salicylates may entirely fail to produce any effect, but under such circumstances it is wise to carefully reconsider the diagnosis. In gonorrhœal rheumatism and in arthritis deformans salicylates are of no benefit, and in gout their usefulness is questionable. In subacute and in chronic rheumatism their action is variable. In tonsillitis of a rheumatic tendency sodium salicylate should always be employed on account of the tendency of such attacks to be followed by acute rheumatism. It is recommended strongly by some authorities for cases of pleural effusion. It is said to diminish the excretion of sugar in some cases of diabetes mellitus. Potassium salicylate has no advantage over the sodium salt and is not so well tolerated. Various other salicylic salts and preparations are in use, and are described under the different headings.

Salicylism.—The toxic effects of salicylic acid and the salicylates. *See* Toxicology.

Saline Infusions. *See* Cholera, Epidemic (*Treatment, Injection of Saline Fluids in Collapse Stage*); Eclampsia (*Treatment, Saline Solutions*); Labour, Post-Partum Hæmorrhage (*Treatment of Post-Hœmorrhagic Collapse, Saline Infusions*); Transfusion (*Methods*).

Saline Purgatives. *See* Pharmacology (*Inorganic Substances, Saline Purgatives*). *See also* under Magnesia, Potash, Sodium, etc.

Saline Solution. — A 0·6 per cent solution of chloride of sodium, also termed *normal* saline solution. *See* Saline Infusions for *Cross References.*

Saline Waters. *See* Mineral Waters (*Muriated Salines*).

Salins.—*See* Balneology (*France*).

Salipyrine. — The salicylate of antipyrine ($C_{11}H_{12}N_2O.C_7H_6O_3$), which has been used, in doses of 15 to 30 grains, in neuralgia and rheumatism, and generally as an antipyretic.

Salisbury Treatment. *See* Diet (*Animal Foods, Meat*); Gout (*Dietetic Treatment, Meat and Hot Water Cure*); Invalid Feeding (*Meat and Hot Water Diet*); Obesity (*Dietetic Treatment, Salisbury Cure*).

Saliva. *See* Salivary Glands.

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The disorders of the Parotid gland have already been considered (vol. vii. pp. 364-368). The other salivary glands are the submaxillary, the sublingual and certain additional glands, the chief of which are the glands of Nuhn or Blandin.

Anatomy

The Submaxillary glands are placed symmetrically beneath the lower jaw, one filling the space on either side which is left between the two bellies of the digastric muscle. Each gland lies in a triangular space formed on two sides by the splitting of the superficial cervical fascia, whilst the base of the triangle is the periosteum covering the inner aspect of the lower jaw. The submaxillary gland is intermediate in size between the parotid and the sublingual, and usually weighs rather more than a quarter of an ounce. It is roughly almond-shaped, but there is a deeper portion which is prolonged forwards and inwards between the mylohyoid, the hyoglossus and the geniohyoglossus muscles and below the lingual nerve.

The superficial portion of the gland is covered by the skin, fascia and platysma: it rests upon the styloglossus, the hyoglossus and the mylohyoid muscles, and is grooved posteriorly and above by the facial artery. The duct of the submaxillary has long been called Wharton's duct, after its discoverer Thomas Wharton, the Yorkshireman (1610-1673). It runs upwards and inwards with the deep portion of the gland, and opens on the top of a small papilla at the side of the frænum of the tongue. The duct is about two inches in length and has a thinner wall than the duct of Stensen. The gland receives its blood supply from the facial and lingual branches of the external carotid artery, whilst the veins empty themselves into the anterior jugular and facial veins. The nerves are branches of the mixed lingual and chorda tympani nerves either directly or by branches from the submaxillary ganglion, as well as from sympathetic branches of the plexus surrounding the facial artery. They are interesting because the termination of nerves in gland cells was first demonstrated in the submaxillary by Pflüger, and more recently by Paladino. The lymphatic glands of the submaxillary region are arranged in two groups, the more anterior lying on the mylohyoid muscle, the more posterior embedded in the submaxillary gland—one or more glands being found between the submaxillary gland and the hyoglossus muscle. These glands are of especial importance as they become enlarged in cancer of the tongue, and in performing any operation for epithelioma both aspects of the submaxillary gland must be carefully examined for enlarged lymphatic glands.

The Sublingual gland lies on the floor of the mouth so close to the mucous membrane that its outline may be seen projecting as a crest running fore and aft on either side of the frænum linguæ. It weighs about two drachms, and is thus the smallest of the three chief salivary glands. The sublingual gland lies upon the mylohyoid muscle, and has behind it and upon the inner side the genio-hyoglossus, the gustatory nerve, Wharton's duct and the deep part of the submaxillary gland. The sublingual gland consists in reality of a number of individual glands crushed together into the semblance of a single gland. It has therefore many ducts; the main one, called the duct of Rivinus or Bartholin, runs close to Wharton's duct, and either opens into it or close to it on the floor of the mouth. The smaller ducts open by eight to twenty orifices on the floor of the mouth between the frænum and the ranine vein. The arteries are derived from the sublingual and submental branches of the facial artery, the veins empty themselves into the ranine, whilst the nerves come from the united lingual and chorda tympani and from the sympathetic.

The accessory glands are the glands of Weber situated at the back and side of the tongue just beneath the circumvallate papillæ and the glands of Nuhn, situated beneath the mucous membrane and some fibres of the genio-hyoglossus muscle at the tip of the tongue, where they open by several ducts.

Inflammations

The salivary glands are liable to inflammation from various causes, the chief of which are injury and infection. Foremost amongst the mechanical causes are calculi.

Salivary calculi are especially liable to be formed in the submaxillary gland and to be arrested in their passage along Wharton's duct, but they are also found in Stensen's duct of the parotid.

Pathology.—Their mode of origin is uncertain. It used to be thought that they necessarily had a foreign body as a nucleus, or that they were formed by the precipitation of the salts contained in the saliva. Advancing pathology, on the analogy of concretions in the vermiform appendix, teaches that although these causes may sometimes act, a slight but chronic microbic infection is the most potent factor. The calculi are usually single, but as many as ten have been found occasionally. The shape is moulded to their situation, usually elongated and rounded when they lie in the duct, they are often irregular in outline when they are removed from the gland. They vary greatly in colour, from white, through grey to red and black. Sometimes they are brittle and are easily reduced to a powder by gently pressing between the fingers, at others they are stonily hard.

Chemically they consist chiefly of carbonate and phosphate of lime with an organic basis. The presence of a calculus may lead to acute dilatation of the gland, to an acute inflammation, which may end in resolution or suppuration, or to a series of chronic changes ending in sclerosis and atrophy.

The symptoms vary greatly. In some cases the calculus may be discharged spontaneously or a pricking sensation may lead to an examination of the floor of the mouth, when the calculus may be seen projecting from Wharton's duct, from which it is easily removed. More usually, however, the presence of a calculus impacted in the duct causes pain, which becomes worse when excitation of the gland leads to increased flow of saliva. The pain may then be very intense, and may radiate to the ear on the same side. It is sometimes accompanied by evidence of vasomotor disturbance, as is shown by an acute œdema beneath the mucous membrane of the floor of the mouth, which is sometimes called an acute ranula.

Salivary calculi have been mistaken at various times for dermoids, lipomata, ranulæ and malignant tumours, more rarely for tuberculous disease, and occasionally for periostitis of the jaw, and for ossifying tumours of the floor of the mouth. It should be borne in mind that calculi in the gland give rise to less marked symptoms than those in the duct, but that, on the other hand, they are more likely to cause an abscess.

The treatment is prophylactic and curative. The prophylaxis consists in keeping the mouth clean and sweet, by brushing the teeth and using appropriate mouth washes: whilst the curative treatment is to remove the calculus. This should always be done, if possible, by an incision inside the mouth, but in long-standing cases where there is reason to think that the submaxillary gland is destroyed as a result of the inflammation, the whole gland may be removed by an incision carried beneath the jaw.

Tuberculous Inflammation of the salivary glands may occur in two forms. It is usually an inflammation beginning in the lymphatic glands lying in immediate relation with the affected salivary gland: more rarely it is a true inflammation of the salivary gland itself. The lymphatic glands are in closer relation with the parotid than with the submaxillary gland, and cases of tuberculosis of the parotid are consequently more numerous than of the submaxillary gland.

Syphilitic Inflammation.—Manifestations of tertiary syphilis have been observed in the submaxillary, the sublingual and more rarely in the parotid gland. In the sublingual the whole gland has become uniformly enlarged: in the submaxillary only portions of the gland are affected, whilst in the parotid it is doubtful whether it is not the lymphatic glands rather than the gland itself which is affected. The prognosis is good, for the swelling subsides when iodide of potassium is administered.

Acute Septic Inflammation of the loose connective tissue of the throat and neck often begins in the neighbourhood of the submaxillary gland. It is known as *Angina Ludovici*, and is of great clinical and pathological interest.

Symptoms.—The inflammation attacks previously healthy persons of both sexes and apparently of any age. The incubation period, if there be one, is not marked by any symptoms. The attack begins suddenly with a rigor which varies in intensity, and is associated with a rise of temperature which reaches its maximum at once. The pulse rarely rises to more than 110-130 beats a minute, and it is characterised by intermittence, weakness and easy compressibility.

The patient complains of pain in the throat with much difficulty in swallowing, attended by great malaise and prostration, and the dysphagia increases until swallowing is impossible. The cellular tissue of the parts involved becomes acutely inflamed. The skin is hot and tense over the whole or one side of the neck, and there is a hard brawny infiltration, the swollen parts being acutely tender to pressure. The exudation into the cellular tissue is generally serous, but there may be diffuse suppuration, and sometimes localised abscesses are formed. Secondary abscesses, too, are sometimes found in the joints and in other parts of the body. Speedy death occurs in the most acute cases; but in others the inflammation subsides within a few hours, or at most a day or two, and the patient rapidly recovers. The exact channel by which the micro-organism enters the body is unknown, though it is presumably through the mouth, for the swelling first appears in the neck and afterwards spreads in both directions. The disease need not necessarily be limited to the parts first affected, for the inflammation may spread rapidly and involve the lungs and pleura, the peritoneum, and the meninges of the brain. Indeed the nervous system sometimes appears to feel the full effect of the poison after the local inflammation has completely subsided.

Treatment.—The treatment is based upon the knowledge that the effect of the poisoning is acute but transient, and that there is especial danger from cardiac failure, from suffocation, and from the difficulty in swallowing. The local inflammation should be controlled at first by cold compresses, but if the dyspnœa is urgent tracheotomy should be done early. When suppuration occurs, numerous small incisions should be made into the œdematous tissues. Stimulants are urgently needed, with such food as the patient can swallow, given frequently and in small quantities. Quinine combined with perchloride of iron and digitalis

will be of service in most cases, and the imperfect oxygenation of the blood may be improved by inhalations of oxygen.

Xerostomia

The salivary glands sometimes strike work entirely and permanently without any known cause, and there results the condition known as xerostomia or dry mouth. But the loss of function is not limited to the salivary glands, for the nose and eyes are often similarly and simultaneously affected. Out of forty recorded cases thirty-two occurred in females, the mouth and tongue were alone affected in thirty-six, the nose also in ten, and the eyes also in seven. In these cases the tongue appears red, cracked, absolutely dry, and the papillæ are markedly atrophied. The inside of the cheeks and the hard and soft palate are dry, whilst the mucous membrane of the mouth is soft, smooth, shining, and pale. The teeth often crumble away or fall out. The general health of the patient remains unimpaired and the digestion does not appear to be affected, though swallowing is difficult and the speech is hampered by the dryness of the throat. All the salivary glands must be implicated, but the parotid alone shows any gross lesions. It is sometimes enlarged either permanently or intermittently, occasionally it is tender and once it ulcerated.

No treatment is curative, but some improvement is said to have taken place after the administration of pilocarpin in doses of one-twentieth to one-tenth of a grain given by the mouth.

Ptyalism

Ptyalism or salivation is an unduly abundant flow of saliva due to excessive activity of the salivary glands. It is thus the opposite condition to that producing xerostomia. It occurs physiologically in pregnancy and during dentition. Pathologically in various affections of the mouth, in hydrophobia, and in some fevers: therapeutically as a result of the administration of mercury, pilocarpin, iodine, and copper salts. The condition must be treated casually, but increased comfort will be obtained from astringent mouth-washes, and especially from a solution of potassium chlorate of the strength of twenty grains to the ounce.

Tumours

The tumours affecting the salivary glands may be classified as innocent and malignant; the innocent tumours being further subdivided into cystic and solid.

Ranula

Ranula is the name given generically to all cystic tumours of the floor of the mouth which are formed in connection with the salivary glands. Ranulæ are either sublingual submental, or congenital.

The Sublingual Ranula is the ordinary form of tumour. It is situated in the floor of the mouth, and appears at first on one side of the frænum of the tongue as a tense, shiny, and bluish swelling, which often attains so large a size as to push the tongue upwards, thus interfering with speech and mastication. The mucous membrane moves freely over the tense cyst, and incision of the swelling allows of the escape of clear fluid, which is sometimes as thin as saliva, but is more often glairy. Microscopical examination of the fluid shows that it contains epithelial cells in various stages of cystic degeneration. Chemical investigation proves it to contain mucin and albumin, whilst it is free from any amylolytic ferment or sulphocyanide of potassium. It is not therefore simple or inspissated saliva.

Pathology.—It was taught for a long time that a ranula was due to blocking of Wharton's duct. But this can be disproved by the fact that in some instances a bristle can be passed along this duct when a ranula is present. Pathological opinion then shifted and said that a ranula was due to a dilatation of the glands of Nuhn or Blandin which lie near the front of the under surface of the tongue covered by some fibres of the genio-hyoglossus. But microscopical examination of the walls of the cyst shows that they contain pouches and diverticula lined by glandular epithelium in various stages of cystic degeneration, and that they are not simply derived from dilated ducts. The more likely explanation of a ranula is to be found in the fact that it is a true cystic degeneration of some of the many glandular structures in the floor of the mouth. Its origin is not always the same, as it may sometimes be formed by the cystic degeneration of the submucous follicle, sometimes of the sublingual gland, and less frequently of the glands of Nuhn.

Treatment.—Simple incision of a ranula is neither easy nor serviceable, as the mucous membrane slides over the tense cyst wall so readily that it is difficult to puncture the cyst, and if only a small opening be made the cyst rapidly refills and becomes as troublesome as ever. The cyst should therefore be dealt with methodically. The patient should be placed in a good light, and the floor of the mouth should be rendered insensitive with cocaine. The mucous membrane is then seized with a pair of nibbed forceps and incised freely over the cyst. The cyst must afterwards be opened, and as much as possible of the wall should be cut away with a pair of blunt pointed scissors. The inner wall of the cyst is then to be well rubbed with a pledget of absorbent wool wrapped round the end of a pair of pressure forceps, and soaked in a solution of zinc chloride (40 grains to the ounce). This rubbing must be done effectually, for the cyst wall may be itself honeycombed with smaller cysts. The cyst is then well washed

out and is lightly stuffed with cyanide gauze. It soon heals by granulation, if the mouth be washed out two or three times a day with a solution of 1·60 carbolic acid.

Submental Ranulæ are much less often seen than the sublingual variety, but I recently had a case in a man of thirty. The swelling appears beneath the chin as an ill-defined and fluctuating swelling, which has none of the tense elastic feeling which is so marked in the more common form of ranula. Submental ranulæ increase very slowly in size, and do not give rise to any troublesome symptoms for a long time.

Pathology.—Their origin is unknown, but it has been suggested that they may be the result of cystic degeneration of outlying parts of the submaxillary or of the sublingual gland, or that they may be sublingual ranulæ which from any cause are unable to extend into the floor of the mouth, and are thus driven to extend downwards instead of upwards. Such a cause would be the scarring of the floor of the mouth produced by the cure of a previous ranula.

Treatment.—A submental ranula which causes inconvenience should be treated through the mouth, if it is possible to make it project upwards, or if it co-exists with a sublingual ranula. More frequently, however, it has to be dissected away through a skin incision carried beneath the chin.

Congenital Ranula is sometimes found on the floor of the mouth in new-born children as a result of the imperfect development of Wharton's duct, though the sublingual or the gland of Nuhn are sometimes at fault.

Treatment.—When Wharton's duct is obliterated the swelling is often bilateral. The treatment consists in snipping off the imperforate papilla with a pair of scissors.

Dermoid Cysts

Dermoid cysts occur in the middle line between the genio-hyoglossi muscles. They grow slowly, and usually do not come under observation before the patient has attained the age of fifteen to twenty. They may be distinguished from ranulæ by their central position beneath the chin, and their walls consist of skin with hair follicles, sebaceous, and sweat glands. They are filled with sebaceous matter, and are often firmly attached to the surrounding tissues. Similar cysts are sometimes seen in the submaxillary region, where they appear to be formed in connection with one of the branchial clefts. Both the lateral and the median dermoid cysts may suppurate.

The treatment consists in dissecting them out if they are unsightly, but the operation must be carried out with due care and deliberation.

The solid innocent tumours of the submaxillary and sublingual glands are adenomata and chondromata, but they are less common than in the parotid.

The Malignant Tumours have the same character as those found in the parotid. They are endotheliomata, formerly called mixed celled tumours, sarcomata in their various forms, and in the case of the sublingual and submaxillary glands, epitheliomata secondary to cancer of the tongue. When the submaxillary gland is affected it should be removed as early as possible.

Salix.—The willow, several species of which contain salicin (*q.v.*).

Salkowsky's Test.—The nitric acid and potassium nitrite test for indol; also, the chloroform and sulphuric acid test for cholesterine.

Salmon Disease.—A disease affecting salmon and other fish, due to the *Saprolegnia ferox.*

Salmon Patch. *See* Cornea (*Interstitial Keratitis, Pink Patch in the Cornea*).

Salocoll.—The salicylate of phenocoll, given as an antipyretic and antineuralgic (in doses of 15 to 30 grains.

Salol.—*Phenyl salicylate* is a white crystalline powder, almost tasteless, insoluble in water, and soluble in alcohol. It is composed of sixty parts of salicylic acid and forty parts of phenol. It is split up into its two components by the pancreatic juice, and possesses the action both of the salicylates and of carbolic acid. If given in too large a dose it may produce symptoms of carbolic acid poisoning. It should not be employed when the kidneys are seriously diseased. It renders the urine dark in colour. It has been used chiefly for its antiseptic action on the alimentary canal and on the urinary system. In cases of flatulence, of diarrhœa, of typhoid fever, of dysentery, of cholera, and the like it has proved very disappointing; but in cystitis and urethritis it is of great value. In rheumatic fever and muscular rheumatism it has seemed to give better results in some cases than the salicylates alone. It is little used, however, for rheumatic conditions.

Salonichi. *See* Balneology (*Turkey*).

Salophen.—A derivative of salicylic acid (acetylparamidophenyl salicylate, $C_{15}H_{13}NO_4$), which has been used, in doses of 15 grains, as a substitute for salicylic acid.

Salpingectomy.—Excision of the Fallopian tube (Gr. σάλπιγξ, a trumpet, and ἐκτομή, a cutting out). *See* Fallopian Tubes (*Treatment of Salpingitis*).

Salpingitis.—Inflammation of the Fallopian tube. *See* Fallopian Tubes (*Inflammation*); Menstruation and its Disorders (*Menorrhagia, Dysmenorrhœa*); Mumps (*Complications*); Ovaries, Diseases of (*Cystic Tumours, Complications*); Sterility (*Etiology*).

Salpingo-.—In compound words salpingo- (Gr. σάλπιγξ, a tube) means relating to the Fallopian tube, less often to the Eustachian tube, *e.g. salpingocyesis* (tubal pregnancy), *salpingopharyngeal* (belonging to the Eustachian tube and pharynx), and *salpingotomy* (excision of or incision into the Fallopian tube).

Salpingo-oophorectomy.—Excision of the Fallopian tubes and ovaries; Lawson Tait's operation.

Salpingostomy. — The operation of restoring the potency of the Fallopian tube in hydrosalpinx. *See* Fallopian Tubes (*Treatment, Operative, of Salpingitis*).

Salsomaggiore. *See* Balneology (*Italy, Muriated Waters*).

Salt. *See* Sodium. *See also* Saline; Epsom Salts; Rochelle Salt; etc.

Salt Cake.—Sulphate of soda as it is made in alkali works.

Salt Lake City. *See* Therapeutics, Health Resorts (*American*).

Saltatory Spasm. *See* Hysteria (*Chorea Saltatoria*).

Salzbrunn. *See* Balneology (*Germany, Alkaline Waters*).

Sambuci Flores.—Elder flowers are used in medicine chiefly as a flavouring agent; they are obtained from the *Sambucus nigra*, and contain a resin, valerianic acid, and a volatile oil (containing a terpene, $C_{10}H_{16}$); there is an official preparation, the *Aqua Sambuci* (dose, 1 to 2 fl. oz.). *See* Elder Flowers.

San Bernardino. *See* Balneology (*Switzerland, Grisons*).

San Diego. *See* Therapeutics, Health Resorts (*American*).

San Remo. *See* Therapeutics, Health Resorts (*Riviera*).

Sanarelli's Bacillus.—The *bacillus icteroides*, once believed to be the specific organism of yellow fever. *See* Yellow Fever (*Virus*).

Sanatogen. — A dietetic preparation containing much casein (90 per cent) and some phosphoglyceride of sodium (5 per cent); it has been recommended as a stimulant and tonic in anæmia and in the neuroses; and it is given in doses of two teaspoonfuls (for adults) twice or thrice daily, mixed with soup or milk or porridge, etc.

Sanatorium.—A private hospital; also with the meaning of *sanitarium*. *See* Lung, Tuberculosis of (*Treatment, Sanatoria*).

Sand Flea. — The chigoe or chigger (*Pulex penetrans*). *See* Skin Diseases of the Tropics (*Animal Parasites, Chigger*).

Sand, Intestinal. *See* Stools, Intestinal Sand; Fæces (*Foreign Bodies*).

Sanders-Wood. *See* Pterocarpi Lignum.

Sandfjord. *See* Balneology (*Norway*).

Sandgate. *See* Therapeutics, Health Resorts (*English*).

Sandrock. *See* Balneology (*Great Britain, Chalybeate*).

Sänger's Method. *See* Labour, Operations (*Cæsarean Section, Operative Methods, Closing the Uterine Incision*).

Sanies. — Sero-purulent discharge, as exudes sometimes from a fistula or ulcer.

Sanitarium. — A health resort, perhaps in special connection with the treatment of tuberculosis. *See* Therapeutics, Health Resorts.

Sanitary Science. — Public health or hygiene. *See* Epidemiology; Meterology; Sewage and Drainage; Vital Statistics; etc.

Sanitas.—An aqueous solution of turpentine which has oxidised in the air; it acts as an antiseptic by reason of the peroxide of hydrogen which it contains. *See* Disinfection (*Chemical Substances*); Hydrogen Peroxide.

Sanmetto.—A proprietary preparation, said to consist of sandal-wood and saw-palmetto; it has been recommended (in teaspoonful doses) in genito-urinary complaints.

Sanoform.—The methyl ether of diiodosalicylic acid, recommended as a surgical dressing (powder or ointment).

Sanson's Images. *See* Physiology, Neuro-Muscular Mechanism (*Vision, Accommodation*).

Santa Barbara. *See* Therapeutics, Health Resorts (*American*).

Santa Margherita. *See* Therapeutics, Health Resorts (*Riviera*).

Santal Oil.—Oleum Santali or oil of sandal-wood (to be distinguished from red sandal or sanders wood) is the volatile oil obtained from *Santalum album*; it contains an alcohol ($C_{15}H_{26}O$), and it has been used, on account of its stimulating and disinfecting influence on the genito-urinary mucous membranes,

in gonorrhœa (dose, 5 to 30 m., as an emulsion or in capsules on account of the taste).

Santalal.—An aldehyde ($C_{15}H_{24}O$) found in oil of sandal-wood.

Santonin. *See also* Amblyopia (*Toxic*); Toxicology (*Vegetable Poisons*); Urine, Pathological Changes in (*Colour*).—A neutral crystalline principle derived from Levant worm-seed or santonica, the unexpanded flower-heads of *Artemisia maritima*. The crystals turn yellow on exposure to light, are insoluble in water, but soluble in alcohol and chloroform. When given in moderate doses it turns the urine first greenish-yellow, then saffron, and finally purple-red; and it may cause chromatopsia. In large doses it gives rise to dangerous toxic symptoms. *Dose*—2-5 grs. *Preparation*—Trochiscus Santonini, 1 gr. in each.

It is a very efficient anthelmintic for the removal of the round-worm (*Ascaris lumbricoides*). Its action on thread-worms (*Oxyuris vermicularis*) is less certain. It should be given on an empty stomach, and two hours later a dose of calomel, followed shortly by a saline purge, should be administered. In cases of thread-worm it may be given in suppository if used at all. It is said to increase visual acuity when the optic nerve is at fault. It sometimes cures incontinence of urine when other remedies have had no effect.

Santorini, Cartilages of.—The corniculate cartilages of the larynx, or the cornicula laryngis. Santorini was a Venetian anatomist of the seventeenth and eighteenth centuries (1681-1737).

Santorini, Duct of.—The accessory duct of the pancreas.

Santorini, Fissures of.—Small fissures in the tragus and in the cartilage of the meatus of the external ear.

Saphenous.—Literally the term *saphenous* means apparent (Gr. σαφηνής, plain or open), and is on that account given to certain parts which are superficial and therefore manifest, such as the *saphenous opening* of the thigh and the long *saphenous vein* and *nerve* which pass through it.

Sapo.—There are three varieties of soap—hard soap, soft soap, and curd soap (sapo animalis).

Sapo Durus is sodium oleate. It is prepared from sodium hydroxide and olive oil. *Preparations*—1. Emplastrum Saponis. 2. Pilula Saponis Composita. *Dose*—2-4 grs.

Sapo Mollis is potassium oleate. In the form of "green soap" it is used largely in medicine and surgery. *Preparation*—Linimentum Saponis.

Sapo Animalis consists chiefly of sodium stearate. Toilet soaps contain a large proportion of stearates.

Hard soap is used as a basis for pills. Either hard soap or curd soap may be employed in the making up of medicated soaps containing such substances as ichthyol, tar, and sulphur. An enema of soap and water, to which may be added turpentine or olive oil if required, is the common form of rectal injection employed to unload the bowels. A small suppository of hard soap is a favourite domestic remedy for constipation in children. Linimentum saponis is used for rubbing stiff muscles, sprains, etc. Alcoholic and ethereal solutions of soft soap are employed for purifying the skin before surgical operations, and also in the treatment of some skin diseases.

Sapræmia. *See* Pyæmia (*Definitions*); Septicæmia (*Definitions and Distinctions*); Suppuration (*Constitutional Symptoms, Sapræmic*); Tumours, Inoperable (*General Management of Septicæmia and Sapræmia*); Wounds (*Absence of Drainage, Results*).

Sapro-.—In compound words *sapro-* (Gr. σαπρός, putrid) means connected with putrefaction; *e.g. saprophytes* (plants living on decomposing substances), *saprogenic bacteria* (those causing putrefaction). *See* Micro-Organisms (*Varieties*).

Saprol.—A liquid disinfectant containing cresols like those of carbolic acid.

Saratoga. *See* Balneology (*America, Alkaline Waters*).

Sarcina. *See* Micro-Organisms (*Bacteria*); Nose, Examination of (*Bacteriological*).

Sarco-.—In compound words *sarco-* (Gr. σάρξ, flesh) has the meaning of fleshy; *e.g. sarcocele* (a fleshy tumour of the testicle), *sarcode* (cellular protoplasm), *sarcoplasm* (the interfibrillar material of muscle), *sarcopterygium* (a vascular pterygium), and *sarcotherapeutics* (treatment by animal extracts).

Sarcocystis Miescheri. *See* Parasites (*Protozoa, Sarcosporidia, Rainey's Tubes*).

Sarcolactic Acid.—Hydroxypropionic acid ($C_3H_6O_3$). *See* Physiology, Tissues (*Muscle, Chemistry of*).

Sarcolemma. *See* Physiology, Tissues (*Muscle, Structure, Covering Membrane*).

Sarcoma. *See* Aneurysm (*Diagnosis, Pulsating Sarcoma*); Ascites (*Causation, Local Disease, Omental Sarcoma*); Bladder, Injuries and Diseases of (*Sarcoma*); Bone, Diseases of (*Sarcoma*); Brain, Tumours of (*Etiology, Sarcoma*); Broad Ligament (*Tumours*); Capillaries, Diseases of (*Nævus, Diagnosis*); Choroid, Diseases of (*Sarcoma*); Hip-Joint, Diseases

OF (*Tumours*); INTESTINES, DISEASES OF (*Malignant Tumours*); LABOUR, PRECIPITATE AND PROLONGED (*Deformed Pelves, Sacral Sarcomata*); LARYNX, MALIGNANT DISEASE OF; LIVER, DISEASES OF (*Malignant Disease*); MAMMARY GLAND, DISEASES OF (*Sarcoma*); MEDIASTINUM (*Growths, Sarcomata*); NOSE, DISEASES OF NASAL ORIFICES AND SEPTUM (*Malignant*); OVARIES, DISEASES OF THE (*Sarcoma*); PREGNANCY, OVUM AND DECIDUA (*Malignant Disease of Decidua*); PUERPERIUM, PATHOLOGY (*Deciduo-Sarcoma*); SPLEEN, MEDICAL AFFECTIONS (*Tumours*); STOMACH AND DUODENUM, DISEASES OF (*New Growths, Sarcomata*); TUMOURS (*Sarcomata*); TUMOURS, INOPERABLE, TREATMENT OF; TUMOURS OF THE SKIN (*Sarcomata*); UTERUS, MALIGNANT TUMOURS OF THE (*Sarcoma*); VAGINA, DISORDERS OF (*New Formations, Sarcoma*); VULVA, DISEASES OF THE (*Sarcoma*); X-RAYS (*Cancer and Sarcoma*).

Sarcomelanin. *See* PIGMENTS OF THE BODY AND EXCRETA (*Melanins of Melanotic Tumours*).

Sarcoptes. *See* PARASITES (*Arthropods, Acarina*).

Sarcosporidia. *See* PARASITES (*Protozoa*).

Sarsaparilla. — *Sarsæ Radix* is the dried root of *Smilax ornata*, imported from Costa Rica and known as Jamaica sarsaparilla. It contains *smilacin* (a neutral principle), resin, and traces of a volatile oil. *Preparations*—1. Extractum Sarsæ Liquidum. *Dose*—2-4 ʒ. 2. Liquor Sarsæ Compositus Concentratus. *Dose*—2-8 ʒ. Although devoid of any known physiological action, sarsaparilla appears to have some general action on the system, and is used empirically as a "blood purifier" in chronic rheumatism and in some skin diseases. It is stated to give particularly good results in cachexia and anæmia resulting from syphilis; and specific affections which prove obstinate to ordinary treatment are said to yield to a mixture of iodide and sarsaparilla. It has been employed in a large number of different forms, including the well-known Zittmann's Decoction, a complicated mixture the composition of which is variously stated by different authorities.

Sartorius.—The name given to the muscle which crosses the legs in the assumption of a tailor's attitude (Lat. *sartor*, a tailor). *See* SPINE, SURGICAL AFFECTIONS (*Injuries of Lumbar Plexas, Paralysis of Sartorius*).

Sassafras.—The dried root of *Sassafras officinale*. It contains a volatile oil the action of which is probably similar to that of other volatile oils. It is hardly ever used, but is a constituent of some of the Decoctions of Sarsaparilla.

Sassy Bark. *See* ERYTHROPHLŒUM.

Saturnism.—Lead-poisoning or plumbism. *See* TOXICOLOGY (*Irritants, Lead*); TRADES, DANGEROUS (*Lead-Poisoning*).

Satyriasis.—Excessive sexual desire in the male; priapism. *See* TABES DORSALIS (*Symptoms, Genital Organs*).

Satyromania.—Satyriasis (*q.v.*)

Sauces. *See* INVALID FEEDING (*Cookery in Diabetes*, etc.).

Sausage-Poisoning.—Allantiasis or botulism. *See* TOXICOLOGY (*Animal Foods and Ptomaine Poisoning*).

Savill's Diseaes.—Dermatitis exfoliativa epidemica.

Savin Poisoning. *See* TOXICOLOGY (*Abortifacients*).

Saviotti's Canals.—Artificial canals in the pancreas believed to be formed by the injection of coloured fluids.

Sayre's Jacket.—The plaster-of-paris jacket, as used in the treatment of spinal disease.

Scabies, or the Itch.

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See also PRURITUS (*Diagnosis*); PUERPERIUM, PATHOLOGY (*Nipples, Scabies*).

SYNONYMS.—*La Gale* (*la Gratelle*), *die Krätze*, *la Rogna* (Ital.). Among stablemen in London the itch is spoken of as the "dukes," very probably, according to Dr. Murray, editor of *The New English Dictionary*, a local or vulgar perversion of yukes—phonetically altered to jukes and dyukes. Compare yuke—regular northern name for itch; also *jücken*, German for to itch; *jeuken*, Dutch.

DEFINITION.—The itch is a disease due to an animal parasite, the *Acarus scabiei*, and is characterised by a special lesion, *i.e.* the burrow of the female, and by multiform lesions produced by the violent scratching.

THE PARASITE.—The Acarus scabei (ἀκαρής, indivisible) (vel Sarcoptes hominis) is not an insect, although it is so stated in some books on diseases of the skin. In the adult condition it has eight legs, whereas insects have only six. It belongs to the Arachnida (a sub-class of the Arthropoda), and is included in the order Acaridea (Cambridge).

The anatomy, physiology, and life-history of the Acarus scabei have been minutely studied by Bourguignon, whose monograph and beautiful plates are well worth consulting. In this place a mere outline only of this truly wonderful creature can be attempted.

The adult female acarus picked out of a burrow is just perceptible to the naked eye as a minute, white, globular speck. Magnified, the animal is seen to be somewhat tortoise-like in shape, and provided with eight legs in pairs: two pairs situated anteriorly near the head, and armed with suckers, and two pairs more posteriorly, with a long seta at the extremity of each leg. The legs are supported by chitinous frameworks ventrally situated. The fore-legs are employed to afford support in starting burrowing operations. The female may contain one or more oval eggs.

The male, whilst agreeing in a general way with the female, is smaller; moreover, the most posterior leg on either side is provided with a sucker instead of a seta for purposes of copulation. Posteriorly, too, in the median line there is a horse-shoe shaped chitinous framework with the penis.

Mégnin gives the following measurements: female 0·30 mm. in length by 0·26 in breadth, male 0·20 by 0·16.

The acarus is oviparous, the impregnated female constructing a burrow or cuniculus, which it leaves no more, to lay its eggs. The burrow is situated in the horny layers of the epidermis, just above the rete cells, which as a rule are not invaded, but in a bad case of itch in a leper with numberless acari, Radcliffe-Crocker noted one acarus among a score in the upper part of the rete. In her progress the female leaves behind a trail made up of ova, usually placed transversely, and fæces, perforating each day, according to Bourguignon the roof of the burrow for air. The acarus has no tracheal system, but breathes by the general surface of the body (Leuckart) and by swallowing air (Bourguignon). The female is said to lay some fifteen to fifty eggs altogether, and once this is accomplished her mission in life is at an end, and she dies. The eggs are variously stated to hatch out in from five to fourteen days, those first laid maturing earliest. According to Dubreuilh and Beille the larvæ find their way to the surface through the roof of the burrow. In the figure of a section through a burrow, magnified, the female and ova in various stages of development can be seen.

The larva has six legs only, and undergoes several moults, not true metamorphoses, before reaching the final adult male or female condition. In the first moult it acquires an extra pair of legs and becomes a nympha, that is, a non-sexually differentiated form. Later on sexual characters are acquired, the females then become impregnated, and start on a fresh cycle for the preservation of the parasite (Mégnin). A moulting phase is shown by Bourguignon in his plate vi. The impregnated females alone burrow; the other forms either wander freely about the body, or merely ensconce themselves in the superficial layers of the epidermis to escape detection (Dubreuilh).

The animal works and feeds at night. It is not, therefore, the warmth of the bed that gives rise to the irritation. In bakers who work by night, Dubreuilh and Beille have noted that the irritation came on about 4 A.M., and lasted for an hour or two. According to Bourguignon patients told him the irritation was greatest between 10 and 12 P.M.

As to the cause of the irritation, the mere movements of the parasite are not sufficient to account for the violent itching. This arises from a venomous fluid (Moquin-Tandon) or irritant saliva (Mégnin) secreted by the acarus and introduced into the skin. Hardy pounded up eight acari in a drop of water and inoculated the back of his hand with the material thus obtained. It gave rise to marked pruritis (Dubreuilh and Beille).

The anatomy of the parasite's head and mouth is extremely complicated. It has been unravelled by Bourguignon, who gives drawings of the magnified component parts. According to him, the acarus punctures its victim's tissues with the sharp ends of its mandibles, and then by a process of squeezing presses out the fluids and blood corpuscles on which it feeds.

Geographical Distribution and Incidence.—The itch is widely distributed all over the globe. As far as England is concerned, it is very common among the poor and not rare in the better classes. Radcliffe-Crocker's figures are 8 per cent for hospital and 3 per cent in private practice. In Scotland it is more prevalent than in England. In M'Call Anderson's practice it occurred in about 16 per cent of his hospital patients, and about $3\frac{1}{2}$ per cent of his private cases. On the continent of Europe it is very common: Brittany, Norway, Italy, Greece, Corsica, and so forth. In the United States it was at one time very uncommon, but of late years it has become more prevalent, White of Boston noting an increase from 9 cases in 1880 to 165 in 1888. There is no doubt the increased immigration of Jews from Poland, Russia, Galicia, etc., has influenced American figures, for in London it is comparatively common among the Yiddish who apply for relief.

I am informed that among the Tamils of Ceylon scabies is almost universal.

The fact is the disease is world-wide, the parasite being everywhere the faithful attendant of man.

Itch is more prevalent in winter than in summer, for reasons not far to seek.

Symptoms.—The features of the disease are the characteristic burrows and multiform lesions,

either due directly to the Acarus scabiei, or arising secondarily as a result of the scratching induced by the irritation.

The burrows or cuniculi appear as more or less sinuous, irregular lines, varying in length. They are usually short, from an eighth to half an inch in length, but much longer ones have been observed. In cleanly people these lines may be white, but in the great majority of cases they are more or less black from dirt.

The lesions directly caused by the acarus may be papules, vesicles, and pustules, but these are not present in connection with all burrows.

Scratching gives rise indirectly to excoriations, secondary pus inoculation lesions of varying degrees of severity, scabbed papules, wheals, and eczematous complications.

The distribution of the eruption, besides being present about the hands and wrists, is found in men to extend from the level of the nipples to the knees in front, the genitalia being very frequently involved, and occupies the buttocks only posteriorly, especially in tailors, carmen, and cobblers. In women, the lower part of the back, being within reach of the hands, is also involved. In them, too, the breasts are often affected. In infants the feet are commonly the seat of pustular lesions. The head and face, except in infants, are free.

The above description applies to an ordinary case, but the eruption is at times so much modified by the individual habits and occupation as to be misleading. In the first place, no burrows may be found, as in bricklayers, washerwomen, and so forth. With very cleanly people, who use plenty of soap and water, and nail brushes, the hands may show very little, and the lesions about the body be slight and indefinite. In such cases the diagnosis may be extremely difficult.

On the other hand, in the so-called Norwegian itch the whole of the body, including the face, may be involved. These extreme conditions have been observed chiefly in lepers, in whom, owing perhaps to apathy and insensibility, the disease goes on for years uncontrolled. In a young tuberculated leper, who was under the care of Radcliffe-Crocker, the limbs were thickly encrusted with an epithelial mortar-like deposit. Scabies was not suspected during life, as the itching was never very great. A portion of skin removed at the necropsy showed the epidermis to be riddled with acari in all stages.

Animal Scabies.—An extreme case of itch contracted from a horse has been recorded by Besnier and Mégnin, in which the latter found the Sarcoptes scabiei, var. equi. The man's eyebrows, beard, and hair were thickly crusted, and his body was covered with closely aggregated papules, giving the skin the appearance of shagreen leather.

Willan and Bateman figure a bad case of itch contracted from a pig.

An ill-defined, slight papular eruption has also been observed in the human subject, contracted from dogs and cats, but the acari of these animals do not thrive on man.

Ætiology.—Scabies is a contagious disorder due to a parasite, and from what has already been said, for the disease to arise it is necessary that an impregnated female should find her way to a new host, upon whom she may start her burrowing proclivities. For this to take place, prolonged contact with itchy persons or things, such as occurs in sharing the same bed, and so forth, must take place. Popularly it is thought that shaking hands is sufficient, but this, to say the least of it, must be a most unusual mode of infection. Wearing infected gloves leads to recurrences in patients who have been cured, and Radcliffe-Crocker has pointed out that the trousers' pockets may be a source of reinfection. In connection with the latter observation, it is possible that the well-to-do may contract the disease from their clothes, for male wearing apparel is made up by tailors in their own homes. Of late years much of this kind of work has fallen into the hands of Jews from Poland and Russia, who are steadily populating Soho and other parts of the West End of London, and, as I have said, scabies is not uncommon amongst them.

The Acarus scabiei is no respecter of persons, the young and old, rich and poor, are all one to him in his determination to perpetuate his species. But where the victim is dirty and careless the parasite stands a better chance in the struggle for survival. Burrowing operations are best carried out undisturbed.

Diagnosis.—In well-marked cases the diagnosis is easy, although from want of attention to *all* the facts the disease is not infrequently overlooked. To avoid errors the patient should be thoroughly examined. This can be done even in the case of private female patients with a little tact.

The distribution as a whole is of primary importance. The lesions about the hands and wrists, scattered about these parts *without order or regularity*, is a striking feature. Burrows should be sought for, with a watchmaker's lens, between the fingers and about the bends of the wrists. With a little care the recent end of a burrow can be made out—indeed, the female acarus can sometimes be discerned as a minute rounded elevation, and by inserting a pin or a finely pointed needle on a holder at this spot the parasite can be picked out. An important point to bear in mind is that the acarus is not to be found in vesicles or pustules. To convince the unbelieving the parasite should be shown under the microscope.

On the other hand, ill-developed cases may present great difficulties in arriving at a correct conclusion. It is here that the social position must not be allowed to influence the judgment

and outweigh all the positive factors taken together. These are—itching at night, especially between the fingers, the distribution of the scratch-marks, the presence of a burrow. As far as the last-named is concerned such may not be found, for the reasons given, even after careful search with a lens. The probabilities of the case being scabies must be carefully weighed, and the diagnosis arrived at even without the assistance of a burrow. A careful examination, however, may be rewarded by finding a burrow, when an attempt to secure the acarus should be made in the manner aforesaid, and its capture would, of course, clinch the matter.

Sometimes the fact that more than one member of a family is affected will be of diagnostic assistance.

In babies an *irregularly scattered* pustular eruption about the hands and feet, especially between the fingers and toes, is practically bound to be scabies, and a little care will usually confirm the impression. The mother in such cases will often be found to be a sufferer herself.

Animal Scabies.—In ill-defined pruritic eruptions contracted from animals the lesions are usually slight. No burrows or acari would be found. The diagnosis would be helped by the knowledge that several children, for instance, were affected, and a pet dog suffering from some skin disease (mange) kept in the house.

Differential Diagnosis.—The chief difficulty presenting itself is the exclusion of eczema of the hands. If it be borne in mind that in eczema the vesicles are minute and grouped, whereas in scabies the vesicles and pustules are discretely scattered about without order, matters will be much simplified. Another point to remember is that an eczema or dermatitis may mask and complicate the scabies as a result of treatment (strong sulphur ointment applied indiscriminately and for a long period). If the eczema be acute and extensive, it would perhaps have to be dealt with first before a definite conclusion could be arrived at. Yet the history of the development and the body-distribution of the general eruption, apart from the eczema, would make the diagnosis certain.

In some rare instances the patient may be suffering from other conditions simultaneously with the itch. For instance, I have seen a bad generalised secondary syphilide complicated with a marked pustular eruption arising from scabies. Its occurrence in leprosy has already been referred to. Again, there may be both pediculosis corporis and scabies, and even in addition pediculi capitis et pubis. I saw a man at the Saint Louis Hospital suffering from severe scabies with no less than twelve indurated chancres about the penis. The virus had found twelve open doors, the result of itch.

Urticaria may be a prominent feature, and quite put one off the track, unless care be taken. This emphasises the importance of careful examination with a lens, which will often be rewarded by the capture of the acarus. The fact that other members of the family itch would be a fingerpost in the right direction.

The differential diagnosis from pediculosis vestimentorum rests on the quite different distribution of the complaint, viz. the upper part of the back and about the shoulders, usually in elderly broken-down individuals (see "Pediculosis").

Urticaria papulosa (*see* "Lichen Urticatus"), which occurs chiefly in children, has more than once been taken for scabies. In the former condition the wheals leave behind them pale red papules with scabbed tops as a result of the marked pruritus. The absence of burrows and of lesions between the fingers would be against itch.

In infants, again, scabies should not be taken for congenital syphilis. Besides the positive signs of the former, the absence of corroborative luetic symptoms would point to the true diagnosis.

Another disease, uncommon in this country, viz. prurigo (Pruritus mitis of Willan and P. ferox of Hebra), would be chiefly excluded by the duration, which would, unless seen very early, extend over years, as it usually begins in the first year of life. In it, as in scabies, the lesions are multiform. They vary from pale, small pin-head papules to pustules. The eruption affects the limbs, which may be covered with red and scab-topped papules and crusted pustular lesions. The skin is rough and thickened as a result of the chronic nature of the disease. No burrows would be found, and the disease is not contagious, though more than one child of the same family may be affected (*vide* "Prurigo").

Barber's itch, barmaid's itch, bricklayer's itch, are not itch at all, but come under Tinea sycosis (barber's itch) or trade and occupation eczemas.

Prognosis.—This is favourable.

Treatment and Prophylaxis.—The first thing to aim at in the treatment of scabies is to open up the burrows that the remedy may reach the acarus. This object is attained by the use of soap and water, and a brush in good condition. A second point of importance is to disinfect the clothes and the bed linen, either by baking or boiling. Old gloves must be destroyed, and Radcliffe-Crocker insists that the trousers' pockets should be hot-ironed thoroughly to prevent re-infection.

From the prophylactic point of view it is very necessary, where several members of the same family are affected, to treat them all simultaneously, otherwise the disease will be perpetuated and become hydra-headed.

A common and effectual method is to rub in ung. sulphuris after opening up the burrows.

This is a little severe in some cases, as it may lead to a dermatitis on its own account.

Where baths can be obtained the disease can be cured in three sittings (three to make sure) in the following way:—The patient soaks in a sulphide of potassium bath at 100° (℥ij.-iv. to 30 gallons) for a quarter of an hour. He is then scrubbed with a hard and sound flesh-brush, and remains in the bath for another quarter of an hour. *The bath must not be* a metal one, as it would be spoilt by the sulphide formed.

In children, and for private cases, the following ointment is sufficient: Naphthol β ℥ss., cretæ prep. ℥ss., adip. ad ℥j. It should be rubbed well in between the fingers and parts affected after soap tubbing and scrubbing with a brush, and left on all night. In the morning a plain warm-water bath should be given. This repeated three nights running, if properly done, will effect a cure. In young children a tooth-brush can be used to open up the burrows.

In poor-law infirmaries the following is used: Quicklime ℥j., sulphur ℥v., water to Oj., stirred up and thoroughly filtered, made up to twenty ounces again, and then with a stiff brush well rubbed into the parts after a soap and water bath.

Many other remedies have been recommended, such as ung. sulph. ℥j., bals. Peruan. ℥j., adipis ℥j.; Styracis liq. ℥j. adipis ℥ij. (M'Call Anderson) —and so forth. The sulphur compounds are liable to set up a dermatitis.

Wearing sulphur bags and sprinkling sulphur in the bed have also been recommended.

Should the patient become re-infected, a little parasiticide ointment (such as naphthol ointment, *vide supra*) should be rubbed into the fresh papules.

In many cases, because the cured patient continues to itch, the parasiticide remedies are continued. This must be avoided. When the treatment has been properly carried out as above the disease is cured, but the skin may require soothing by means of lotio calaminæ for instance. In scabies it is as great a mistake to over- as to under-treat.

In connection with treatment, a few words must be devoted to those cases in which, as a consequence of the disease, the patient gets itch on the brain—a SCABIES CEREBRI. Hence one has to deal with a stereotyped delusion, and it is impossible to convince such patients that they are freed from their parasites. Others, again, have never had itch at all, but labour under the idea that they are loathsome and full of the vermin. Needless to say, that way madness lies. Where argument is fruitless, restraint becomes necessary, and to this end the relatives or friends should be informed of the true state of affairs. Dubreuilh and Maillard have observed scabies cerebri in several members of one family in which a case of suspected itch had occurred. (*See* "PEDICULOSIS.")

THE OTHER ACARI WHICH ATTACK MAN ARE THE FOLLOWING:—

I. THE HARVEST BUG (so-called *Leptus autumnalis; rouget, vendangeur, aoutat; die Ernte*— or *Grasmilbe*).—Mégnin has shown it to be the six-legged larval form of *Trombidium holosericum*. In the adult condition this tracheal breathing acarus is a vegetarian, but in its larval state it is carnivorous, not only attacking man, but also various animals (dogs, rabbits, etc.).

Geographically it is widely distributed. In Britain it flourishes during July and August (but in dry summers it may be found later) in gardens, on legumens, raspberry and currant bushes, etc., etc., and is especially prevalent apparently near the sea and on chalk. Maude has observed it to be absolutely limited to the chalky slopes near Westerham in Kent, but the parasite also occurs on other geological formations (for instance Jurassic or Oolite). It is just visible to the naked eye as a small speck, some shade of red; its colour has been variously described as brick red, bright scarlet, *rouge orangé*, like Cayenne pepper, dull red, etc. Its movements are extremely active and rapid. Women and children are specially liable to its attacks, the ankles and legs being the parts most usually affected. Men wearing knicker-bockers are more liable than individuals in trousers. The parasites fix themselves to the skin, according to some at the base of the hair, but in a case recently (Sept. 1901) under my observation I could not confirm this with a lens. The fact is, the animal drops off its victim once it has gorged itself with blood, and as my patient came up to town from the south coast, my unsuccessful search may be thus accounted for. The time to look for the parasite would be when it is feeding.

Trouessart has shown that the harvest bug's rostrum or haustellum is filiform. On removing the parasite from the skin, this appendage may be surrounded by a tubular-shaped dermal eschar, which Gudden had mistaken for a part of the feeding apparatus. The larva does not burrow under the skin after the manner of the female acarus scabies. At the seat of its operations it gives rise to a small vesicle, which rapidly breaks down and itches most intolerably, leading to violent scratching. Hence wheals and scabbed superficial ulcerations, to which may be added the results of pus inoculation, and sometimes eczematous complications. Other parts of the body besides the legs below the knees may be affected. I have seen scratch lesions, few in number, about the pubes, thighs, and forearms. In another case—a young girl—the scratching had been so violent, the patient remaining without treatment and subjected to repeated invasions of the parasites, that the crusted ecthymatous ulcerations about her legs gave rise to a suspicion of syphilis, which was at once dispelled

by the distribution, mode of onset, and other facts. The scalp is also said to have been affected. In a dying, comatose, phthisical patient, Gudden observed larvæ in enormous numbers, forming red areas on the skin. They had apparently been brought to the patient's bedside in bunches of flowers. Mégnin has pointed out that harvest bugs may be carried in wheat-sheaves and affect the men handling them at a distance from infected localities. In sensitive patients there may be some febrile disturbance.

Diagnosis.—The distribution, itching, and the character of the lesions, together with the time of year, and the fact that the patient lived in the country, would point to the probability of a harvest-bug origin. The sex, too, would help. A search for the parasite, with a lens and a needle on holder, might be rewarded, but the diagnosis must be made apart from the clinching capture of the acarus. The possibility of the conveyance of the parasite to towns in sheaves, perhaps in trusses of hay, etc., must be borne in mind. Scabies can be excluded by attention to the points alluded to above (*vide* p. 32).

In dogs the harvest bug is found chiefly about the orbits and nose. Animals may be carriers of the parasite to man.

Treatment and Prevention.—A number of remedies have been recommended: benzine, essential oils, paraffin, kerosene, phenate of soda, balsam of Peru, etc. No doubt all of them are effectual, but if a patient must continue to reside in an infected locality prevention must be aimed at. Women and children should wear thick stockings, the open-work kind being strictly discarded. Maude has found keeping the legs below the knees dressed with the following useful: Ol. eucalypti, ol. amygdal, āā ʒj., ol. menth. pip. ɱx. As the parasite appears to be active only in the late afternoon and evening, sitting out of doors should be avoided; and lawns near the house should be kept watered and well mown. The following will also be found useful: Naphthol, cret. præp. āā ʒss., adipis ʒj., ft. ung., or ung. hydrarg. ammon. dil. (gr. x. ad ʒj.).

II. Demodex folliculorum (also *Acarus, steatozoon, entozoon, Simonea folliculorum; die Haarsack*—or *Haarbalgmilbe*).—Like the Acarus scabiei, this parasite is a non-tracheate acarus. It is a minute, worm-like, degenerate arachnidan, with an elongated abdomen distinctly marked off from the cephalo-thorax, which bears four pairs of stumpy legs. It was first described by Henle (1841) and more fully by G. Simon (1842).

In length it varies from one-tenth to two-fifths of a millimetre, the abdominal portion measuring about two-thirds of the entire length. The rostrum is spade-like, and is supported by palpi made up of four joints, the terminal one being supplied with a hook, curved downwards, for locomotion and penetration. It infests the sebaceous glands and comedones, and usually several parasites are found together, but fifty, or even as many as two hundred, may be found in one follicle. They are of common occurrence, being found in about one person in five readily, but not in the new-born. The skin about the nose is a favourite situation, but Mibelli and Majocchi have found them in the Meibomian, and Henle originally in the ceruminous glands. In man they rarely give rise to any inconvenience or symptoms, but de Amicis and Majocchi have described pigmentation of the face as a complication. Dubreuilh has recently recorded a marked case of the kind in a lady of forty, in whom scrapings from the face revealed the parasite in all stages of development in enormous numbers; but there was no sign of *Microsporon furfur*, showing it was not Tinea versicolor, for which disease, though rare on the face, it might have been taken. Domestic animals (pigs, cats, sheep, etc.) also suffer from various kinds of demodex. Follicular mange in dogs caused by a demodex may prove fatal, but Mégnin, in opposition to Delafond, Bourguignon, and Gruby, considers Demodex caninus is a different species, and not communicable to man. Demodex folliculorum can usually be readily found in individuals with a greasy skin, by expressing the sebaceous glands or comedones with the back of a knife and examining the teased debris in glycerine. Where there is pigmentation antiseptic applications should be tried, but Dubreuilh in his case found that a chrysarobin and salicylic acid ointment and ung. hydrarg. ammon. led to no change after three months. (Chrysarobin, be it said in passing, should not be applied to the face.)

III. Dermanyssus avium (*Die Vogelmilbe*).—This tracheate acarus belongs to the family *Gamasidæ*. It infests poultry, and may attack man. The parasite is nocturnal in its feeding habits, lying low during the day in the cracks and crevices of hen-houses and hen-coops. Persons tending fowls are liable to their attentions. The parasite is only a temporary guest, but may repeatedly visit its host, giving rise to recurrent pruritus. The proper treatment is therefore preventive, and to this end hen-houses, etc., should be thoroughly disinfected with lime and hot water. The itching itself may be allayed by a lotion composed of liq. carbonis deterg. ʒj.-ʒij., aq. ad ʒviij.

IV. Ixodes (*Wood-ticks, Poux de bois, der Holzbock*).—This is a tracheal-breathing acarus, and, as its name indicates, it inhabits woods, etc. There are several species which temporarily fasten on man and various animals. They are not fastidious as to the host as long as they can get their meal. Wood-ticks are distinguished by the great extensibility of their integuments, swelling up to a large size (a pea or so) after a meal.

The species most common with us is Ixodes reduvius or ricinus. The female alone is parasitic, the larvæ, nymphs, and males only fixing themselves on man and animals for purposes of transport. The acarus is armed with a rostrum, which it bores into the skin, and as it is provided with minute barbs directed backward (after the manner of arrow-heads and fish-hooks), it becomes very firmly anchored in the integument. The parasite should therefore never be forcibly removed, as in that case the rostrum would break off in the puncture and give rise to pain and inflammatory swelling. The animal should be either allowed to finish its meal, or a drop of some essential oil, or turpentine, or benzine placed upon it, when it will withdraw its proboscis and die. Soldiers in the United States use tobacco juice. Blanchard has recorded the curious case of a man who complained of a small growth about the size of a hazel nut on the abdomen. It was removed, and on cutting into it, a fecundated female Ixodes ricinus (or reduvius according to Mégnin) was discovered. The creature was 8 millimetres long and of a yellowish white. Similar cases have been observed by others. Although harmless as a rule to man, ticks are responsible for Texas cattle fever, probably by inoculating a hæmatozoon, *Piroplasma bigeminum*.

Argas.—This genus is closely allied to ixodes and belongs to the same family (*Ixodidæ*). The Argas acari differ in their not being provided with a cephalo-dorsal plate. A European species, Argas reflexus, is parasitic on pigeons, and infests pigeon-lofts. In old disused lofts it may survive for long periods without food. Argas reflexus sometimes attacks man. It is nocturnal in habits, and in its mode of feeding resembles ixodes. It may produce various lesions, such as a crown-sized œdematous patch, extremely itchy, which usually subsides in the course of a few hours, but instead, it may increase in size and spread up the limb, giving rise to burning sensations, accompanied by a vesicular eruption. Giant urticaria may also occur, and affect many parts of the body, including the tongue, etc., with diarrhœa and vomiting. At the seat of the puncture a small hard papule may persist for months and even years. As in the case of ixodes, if the parasite is removed before it has finished its meal, the rostrum is left behind in the small wound. The treatment is the same as for ixodes.

In the north of Persia (Meana), Argas persicus is said to give rise to severe constitutional symptoms in Europeans, the natives being immune. It goes there by the names of *Guerib-guez*, *Malleh*, and *Keuchbhed-guez*. On the other hand, Laboulbène and Mégnin throw some doubt on the accounts of travellers as to the serious results. These two observers experimented on themselves with two Persian species, Argas persicus and A. Tholozan, which had been sent to them and kept without food for four years. They only experienced marked pruritus, with the production of a small violaceous ecchymosis at the seat of puncture, but no other untoward symptoms. Tholozan, who practised for years in Persia, has confirmed the evil reputation of Argas persicus. It infests old houses, lying perdu during the day in the cracks of the walls and floors, and issuing forth at night to feed on man and beast.

In Portuguese South Africa, Argas moubata, first described by Livingstone (Ambaca and Tete on the Zambesi. In the latter place it is called *Kufu* and *Bu*), (*Garrapata* and *Tampan* by the Portuguese). In addition to local irritation, vomiting and purging may occur. Daniels has also found it in British Central Africa. It is very necessary to search mosquito nets for the ticks before retiring for the night.

Mégnin also mentions Argas Americanus (called *Clinche* and *Nigua* in South American Columbia), which is perhaps the same acarus as Argas Talafe, which worries travellers at night in Guatemala. In South America both ixodes and argas are popularly styled garapatas.

Addendum.—(*a*) Acarus hordei (*Kritoptes monunguiculosus*.—Geber has given this name to a larval form found in barley, and which affects the harvesters, giving rise to great itching, eczema, or a marked urticarial eruption. Koller has also seen many cases.

(*b*) Tydeus molestres, according to Blanchard, is common in Belgium, the acarus having been imported with guano from Peru. It attacks man and animals, giving rise to smart itching.

Scala.—Literally a ladder, the term is applied to the ladder-like structure in the cochlea of the internal ear; it consists of two parts, *scala vestibuli* and *scala tympani*. *See* Physiology, Neuro-Muscular Mechanism (*Hearing*, *Internal Ear*).

Scalds. *See* Burns and Scalds.

Scalene. — Having unequal sides (Gr. σκαληνός, uneven); *e.g.* the *scalene tubercle* of the first rib, or the *scalenus anticus* muscle of the neck, which is inserted into the scalene tubercle and gives it its name.

Scalp. *See also* Brain, Affections of Blood-Vessels (*Thrombosis, Cerebral, Œdema of Scalp*); Head (*Scalp Wounds*); Heart, Myocardium and Endocardium (*Symptomatology, Dropsy, Œdema of Scalp*); Insanity, Pathological Anatomy (*Scalp*); Lupus Erythematosus (*Site, Scalp*); Neurasthenia (*Symptoms, Tenderness of Scalp*); Rheumatism in Children (*Subcutaneous Nodules of Scalp*); Skin, Diseases of Sweat and Sebaceous Glands (*Seborrhœa of Scalp*); Syphilis (*Tertiary, Oste-*

itis, Scalp); TUMOURS OF THE SKIN (*Molluscum of Scalp*).—Among the important anatomical and physiological points to be borne in mind in connection with the scalp are—(i.) the great vascularity of the tissue, in virtue of which the healing power of wounds is promoted; (ii.) the richness in vessels and lymphatics is a source of danger in the absorption of toxines generated locally—this holds true very especially of such conditions as erysipelas; (iii.) the relationship of the scalp to the hair and hair bulbs — of special importance in relation to conditions of seborrhœa and allied disorders.

The injuries of the scalp do not call for special notice. They are to be treated on general surgical principles, *i.e.* asepsis. The rare form of injury to the scalp associated with child-birth (Cephalhæmatoma neonatorum) is described in vol. vii. p. 61. The scalp is liable to injury in cases of severe head injuries, but in these instances the lesion of the scalp is of little moment in comparison with the more severe injury to the intra-cranial contents (*see* "BRAIN, SURGERY OF," vol. i.).

The only disease of the scalp calling for special notice is erysipelas. Erysipelas of the scalp is an important disease from two points of view. In the first place, the disease is, even in apparently slight cases, always one of considerable gravity, as a very acute general systemic infection may develop and terminate fatally. And secondly, the sequelæ of the disease are of great importance, and merit more attention than they generally receive. The writer lately saw a patient, a young woman, æt. 26, whose history was as follows: Erysipelas of the scalp (severe) in October 1901, acute mania at end of November, followed by recovery and two relapses, gradually developing asthenia and emaciation, death occurring in February 1902. At the post-mortem examination there were found gross intestinal changes, evidently of a few months' duration, which were probably the focus of absorption of toxines inducing the severe mental changes. The original attack of erysipelas had apparently so lowered the general immunity as to allow acute bacterial infection of the alimentary canal, with all its attendant results, in this particular case. Such a record emphasises the importance of due consideration being paid to erysipelas of the scalp, from the point of view of its remote effects in diminishing the general and local powers of resistance in the individual.

Scammony.—SCAMMONIUM is a gum resin obtained from the living root of *Convolvulus Scammonia*, grown in Syria and Asia Minor. It occurs as flat, greenish, or blackish cakes, soluble in alcohol and ether. *Dose*—5-10 grs. SCAMMONIÆ RESINA is obtained from the dried root by percolation with alcohol and precipitation with water. *Dose*—3-8 grs. *Preparations*—1. Pilula Scammonii Composita. *Dose*—4-8 grs. 2. Pulvis Scammonii Compositus. *Dose*—10-20 grs. Both contain Jalap. Scammony is a drastic, irritating, hydragogue cathartic, which causes a good deal of griping. It must not be used if any inflammatory condition of the bowel is present. It has an anthelmintic action on both round-worms and tape-worms.

Scapho-.—In compound words *scapho-* (Gr. σκάφη, a tub or small boat) means like a boat (projecting like the keel or hollowed out like the anterior); *e.g. scaphocephaly* (the malformation of the skull on which a projecting ridge is produced by premature ossification of the sagittal suture). *See* MENTAL DEFICIENCY (*Hydrocephalic Cases*).

Scaphoid.—Boat-shaped; *e.g.* the *scaphoid bone* of the carpus and tarsus (the latter is also called *navicular*), the *scaphoid fossa* of the internal pterygoid plate of the sphenoid bone, and the *scaphoid abdomen* (a sign of meningitis).

Scapula. *See* FRACTURES (*Scapula*); MUSCLES, DISEASES OF (*Idiopathic Muscular Atrophy, Facio-Scapulo-Humeral Type*); OSTEOMALACIA (*Changes in Scapula*); SHOULDER, DISEASES AND INJURIES OF (*Various Morbid States of Scapula*).

Scapulectomy. — Excision of the scapula.

Scapulodynia. — Pain, rheumatic or neuralgic, in the scapula; omodynia. *See* RHEUMATISM, CHRONIC.

Scarification.—The making of numerous small punctures in the skin or in an internal organ (*e.g.* the cervix uteri or the tonsils).

Scarlatina. *See* SCARLET FEVER.

Scarlatiniform Rash.—A skin eruption resembling that of scarlet fever and met with in sepsis, after the use of antidiphtheritic serum, etc.

Scarlet Fever.

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See also Brain, Inflammations (*Acute Encephalitis, Etiology*); Bronchi, Bronchitis (*Acute, Etiology*); Chorea (*Etiology*); Deafmutism (*Acquired*); Dengue (*Synonyms, Diagnosis*); Diphtheria (*Diagnosis*); Disinfection (*Period of Quarantine*); Epidemiology (*Seasonal Fluctuations*); Gout (*Simulation of Scarlet Fever*); Hæmoglobinuria (*In Fevers*); Hip-Joint, Diseases of (*Pyogenic Diseases in Scarlet Fever*); Hydropathy (*Acute Diseases*); Infection (*Prevention of Infectious Disease, Rules of Quarantine*); Joints, Diseases of (*Pyogenic Diseases*); Kidney, Surgical Affections of (*Perinephritis*); Leucocytosis (*Causes*); Measles (*Diagnosis*); Mental Deficiency (*Acquired, Post-Febrile*); Meteorology (*Seasonal Prevalence of Scarlet Fever*); Miliaria (*Symptom of Scarlet Fever*); Milk (*Pathological*); Nails, Affections of (*In Acute Exanthemata*); Nephritis; Nerves, Multiple Peripheral Neuritis (*Etiology*); Nose, Diseases of Nasal Orifices and Septum (*Perforation of Septum Nasi, Causes*); Nose, Post-Nasal Adenoid Growths (*Scarlet Fever after Operation on Adenoids*); Nose, Accessory Sinuses, Inflammation of (*Etiology*); Pericardium, Diseases of (*Pericarditis, Etiology*); Pleura, Diseases of (*Acute Pleurisy, Etiology*); Pneumonia, Clinical (*In Childhood, Diagnosis*); Pregnancy, Affections and Complications (*Fevers*); Puerperium, Pathology (*Septicæmia, Diagnosis*); Pulse (*Significance*); Purpura (*Symptomatic Variety, Infectious Fevers*); Stomach and Duodenum, Diseases of (*Infective Gastritis in Scarlet Fever*); Therapeutics, Serum Therapy (*Toxic Effects of Antidiphtheritic Serum*).

I. Nomenclature.—Scarlet fever; scarlatina; febris rubra; scarlatine; Scharlachfieber.

II. Definition.—A zymotic disease characterised by a hyperæmic exanthem of a punctiform character, diffused more or less over the entire surface of the body, which appears on the second day. It is preceded by an inflammation of the fauces, and followed by general desquamation. It is attended by fever and nervous symptoms; and the joints, serous membranes, glands, kidneys, and the subcutaneous areolar tissue are frequently involved. The entire disease is the exhibition of an infection of the organism by a specific bacillus, termed the streptococcus conglomeratus.

III. History.—Hirsch furnishes the first account of the disease as emanating from Sicily in 1543; while Ingrassias of Palermo described it in 1556. In the beginning of the seventeenth century Sennert refers to scarlet fever as another form of measles. But it was not until the sixth decade of the seventeenth century that Sydenham definitely established the distinction between scarlet fever and measles. He was followed by Morton, who, at the close of the same century, again maintained the identity of the two diseases, with a differentiation only in respect of the character of the exanthem. Since that date scarlet fever has been regarded as a distinct disease. From Western Europe, where it apparently originated, it has been constantly existent in sporadic cases, becoming epidemic from time to time, but without any regular periodicity. By means of the personal intercourse which commerce involves the disease has been conveyed to other countries,

mainly those of cool or cold climates; just as in countries of variable climate, like Great Britain, the cooling autumn favours its development.

IV. Geographical Range.—The origin and native habitat of scarlet fever are unknown; nor do we possess any knowledge of the period when it first became prevalent on the continent of Europe, so intimately was it confused with measles. From Europe it has extended over most parts of the world, and more freely, in later times, on account of the extension of commerce. It appeared in Iceland in 1827, but not until 1847 in Greenland. Its presence in Africa, and especially Egypt, has been insignificant; and it is rarely found in Asia, except on the coast of Asia Minor. In India and China occasional sporadic cases only occur, and in Japan the disease is unknown. It reached North America in 1735, but was absent from South America until 1829. Its final appearance in Austria and Polynesia occurred in 1848; in New Zealand in 1854.

V. Etiology.—(i.) *Predisposing Causes.*—1. Age.—The greatest number of those affected, and those who are attacked the most severely, are children. During the first year of life, however, the liability to attack is a minimum; during the fifth and sixth years it reaches a maximum; and the susceptibility then decreases annually throughout life.

2. Sex.—The female sex throughout life is the more liable to scarlet fever in the proportion of about eleven to ten; but a fatal termination is more probable in males.

3. Season.—In this country scarlet fever is undoubtedly a seasonal disease; its minimum of cases occurs in March and April; the maximum in September and October, while its limit is attained in the last week of the latter month—in other words, its frequency begins to increase in the first cool days following the summer. It should thus be borne in mind that scarlet fever is mainly an autumn, and not a spring disease. Moreover, the mortality, as well as the prevalence, is greatest in the autumn, and least in spring. On the other hand, Dr Ballard found that the fatality, or case-mortality, was diminished during the third, or summer quarter; increased during the first, or winter quarter; while in the spring and summer quarters the rates of mortality were equal.

4. Locality exercises some influence, as evidenced by the manner in which the disease frequently spreads in certain places, while practically absent in others.

5. Idiosyncrasy.—Few diseases exhibit so extensive a diversity in character. Sometimes the ailment is so slight that the patient experiences no sensation of illness, and during the entire period continues his ordinary mode of life; at other times its virulence is sufficient to cause a fatal termination within a few hours. Uncertainty also attends its power of infection, for even in an epidemic (and this feature is still more manifest in families) some will fail to be affected, however closely exposed; in others the attack will be so slight as to be scarcely recognisable; while the remainder may suffer so severely that, even when a fatal result does not rapidly ensue, few of the internal organs will escape its ravages, although the source of infection may have been of the mildest character. That is to say, the most virulent poison may occasion the mildest infection to another patient, and *vice versa*. Some families, too, are so susceptible to the poison that every member of the younger branch dies when attacked. And occasionally individuals are found who are apparently so influenced by the poison that they contract the disease in some form whenever exposed to the disease, manifesting headache, sickness, malaise, and sore throat, though usually without a rash; and persons so affected are able to give true scarlet fever to others in contact with them.

6. Station in Life.—There can be no question that poverty, implying, as it does, deficient nutrition, inefficient nursing, and overcrowding in badly ventilated rooms, tends not merely to produce an increased frequency of the disease, in consequence of the impossibility of isolation, but also to augment its mortality and its fatality.

(ii.) *Exciting Causes.*—1. Contagion.—The essential cause of scarlet fever has long been suspected to be a micro-organism, which extends from case to case by direct infection; and indirectly through the medium of the attendants, or visitors, on the sick; or by means of the fomites contained in the room, furniture, clothes and laundry, books, toys, letters, and photographs. The bacillus is not only present in the skin, but is probably contained in all the secretions. It is undoubtedly emitted in expired air, in the nasal and pharyngeal secretions; and the probability of its presence, as in typhoid fever, in the urine and the alvine evacuations almost amounts to a certainty.

2. Distance of Transmission of Poison.—The distance of conveyance by aerial convection is not great. This is manifest from the fact that residents in the immediate vicinity of a fever hospital do not suffer in consequence as those do who live in the neighbourhood of a small-pox hospital. The disease, however, will spread in a ward or in a family residence; though, on the other hand, personal contact may be the producing cause in such instances.

3. Mode of Communication.—In addition to personal contact, dispersion can also be effected through the medium of pet animals, and insects such as flies. The disease is not, however, water-borne; but it can be contracted by visiting the dead. It might be conjectured, *à priori*, that fresh milk would form an excellent channel

for the propagation of the germs, and in 1870 Dr. M. W. Taylor showed that the disease could be disseminated through milk which had become contaminated by those who were either infected with scarlet fever or were in attendance on scarlet-fever patients. Since that date many epidemics have been traced to this source. In 1882 Mr. W. H. Power and Dr. Klein proceeded a step farther, and clearly proved that human scarlet fever may be caused by milk which owed its infective property to a similar ailment in the cow itself. Thomas records cases, too, of persons who were inoculated successfully with the germs of scarlet fever, and were thus protected. We shall now discuss the nature of these germs.

4. Bacteriology.—The recent researches of Dr. Mervyn Gordon have confirmed the views of Hallier and Reiss in 1869, and those of Jamieson and Edington in 1887, that the blood of scarlet-fever patients contains micrococci in abundance. These investigations also support Dr. Klein's contention, based upon analyses made during the Hendon epidemic in 1885, that streptococcus scarlatinæ, though closely resembling streptococcus pyogenes, is a distinct organism, and is causally related to scarlet fever. As a result of his most recent investigations into the bacteriology of scarlet fever, Dr. Gordon summarises the evidence as follows :—

(1) The streptococcus scarlatinæ, or conglomeratus, is a special pathogenic micro-organism distinct from streptococcus pyogenes on the one hand, and from bacillus diphtheriæ on the other.

(2) It occurs constantly in the mucous secretion on the surface of the tonsil or fauces in scarlatina, and may persist there, in some instances, for a period considerably remote from the origin of the attack.

(3) It was not discovered on inflamed, but non-scarlatinal throats, though other virulent streptococci were found.

(4) It may be present in the nasal discharges of scarlatina ; but it has not yet been detected in the aural discharge.

(5) It can penetrate the system, and be obtained in pure culture from a serous effusion occurring as a complication in the course of scarlet fever.

(6) It may be present in the blood and tissues of the fatal cases of scarlet fever, and may not infrequently be obtained thence in pure culture.

(7) The characters of streptococcus scarlatinæ, as isolated from the tonsil of a mild but typical case of scarlet fever, are apt to undergo modification, when, for example, a mouse dies from infection with it ; and a similar modification is found in the case of streptococcus obtained when a patient succumbs to scarlatinal infection. In each instance the modification generally comprises increase of virulence accompanied by diminution of those morphological and cultural characteristics that distinguish streptococcus scarlatinæ from the streptococcus pyogenes, though close examination shows that sufficient differences still survive to permit the differentiation of this streptococcus from streptococcus pyogenes. The conclusion is warranted that streptococcus scarlatinæ, or conglomeratus, is the essential agent of the disease termed scarlet fever.

These researches are confirmed by Bajinski and Sommerfeld, and to a certain extent by Class.

5. Fomites.—In calculating the incubation period of scarlet fever, and in predicting its cessation, the action of fomites in renewing the disease must be incessantly borne in mind. And it is undoubtedly the fact that it is the activity of these fomites, infected at the most infectious period of the disease, which accounts also for many cases where it has been assumed that the convalescent was still infectious, and constituted the cause.

These facts are sometimes forgotten in the case of "return" attacks of scarlet fever, and are omitted in the views of those who assign long periods of incubation to the disease. Murchison cites Hildebrand as catching scarlet fever from his own cloak, which, after exposure to its infection, had been locked up for eighteen months ; and adds that if he had put on his cloak at the end of one month, instead of eighteen, after visiting the patient who infected it, and had then been attacked, the case would have been quoted in proof of the possibility of the incubation period extending over four weeks.

6. Independent Origin.—No known case exists of the disease arising *de novo*. It is always dependent upon a previous case.

VI. Symptomatology. — (i.) *Premonitory Symptoms.* — Scarlet fever, even in its most classical form, is one of the most irregular of diseases. The most perplexing cases are those where the symptoms are too slight to render an accurate diagnosis possible without waiting for the course of events. But the position is not peculiar to medicine, that inadequate data mean suspension of judgment. The most vigilant watching at every stage of the disease is essential to valid decision. One of the cases that caused me great trouble was that of a lad who never felt ill for an hour, went to school the whole time, and where the presence of the malady was only discovered by the peeling of his hands.

There are usually, however, some symptoms of invasion even in slight cases, such as feeling tired, headache, chilliness, aching limbs, and loss of appetite. In more decided cases there occur, in addition, severe headache, thirst, vomiting, and sore throat ; while in very young children the onset may be ushered in with convulsions. Occasionally diarrhœa occurs at the commencement. After a few hours of malaise the sore throat, with difficulty in de-

glutition, becomes a marked symptom. The type of the invasion indicates the nature of the supervening illness. In minor cases the countenance reveals nothing at the beginning of the attack; and in severe instances only the bright eye and sharp expression, incidental to the onset of all diseases, attended with an increase in temperature.

(ii.) *Predisposition.*—The predisposition to scarlet fever is not confirmed as in the case of measles, chicken-pox, and whooping-cough, from which few children escape. In scarlet fever many may never be attacked, however freely exposed; others may avoid it for years and then succumb. For instance, I lived for two years in the midst of the infection and escaped; but a year afterwards I suffered without being able to trace the source.

In a community which has been free from measles for some years the malady, once originated, spreads rapidly, and few escape, notwithstanding every precaution in isolation. The action of scarlet fever is different, and even in a very susceptible community, if care be exercised, one or two cases only may arise.

Poverty and exposure intensify the virulence of the disease, and tend to produce severe sequelæ; while affluence, efficient nursing, and fresh air mitigate the severity and prevent sequelæ in many instances. These conditions, however, have no effect on those who, in consequence of idiosyncrasy, are liable to speedy death from an attack.

(iii.) *Sensations of Illness.*—In slight attacks no apparent illness is discoverable. But I have never seen a case with an intense eruption where the patient was not really, and also felt ill. This symptom is of importance in distinguishing scarlet fever from what I have termed the "Fourth disease," when, however copious the eruption, no appearance or sensation of illness may be preceptible.

(iv.) *Temperature.*—In the mildest type of this illness there is practically no fever, the thermometer rarely reaching 100° F. The average, and the severe type, similarly with the other symptoms of onset, commences with a sudden rise, which continues increasing until the eruption has fully appeared on the third or fourth day, when, if the illness is of a favourable type without complication, the temperature gradually falls. On the other hand, if the more severe type (scarlatina anginosa) is presented, or complications are imminent, the fever continues a longer period. The evening temperature in the benign type varies from 102° to 104° F., or about two degrees higher than that of the morning, and by the end of the week the normal temperature is reached. But in the latter type the temperature gradually assumes the suppurative form with a very high range in the evening and a very low one in the morning, exhibiting a variation of six or seven degrees. This continues until the second week, when, if a favourable turn be taken, the variations gradually diminish down to normal towards the end of the third week. If, however, an unfavourable course occurs from prostration or complications, the excessive temperature is maintained until death. The temperature rises in some cases of scarlet fever to a higher point than in any other eruptive fever. The skin presents the sensation, too, of the most pungent heat.

The temperature in ordinary cases of scarlet fever never increases in the usual ratio with the pulse; that is to say, in scarlet fever there is always a markedly accelerated pulse from the beginning, even where the temperature ascends only to 100° F. And a full rash in scarlet fever always implies a high temperature.

(v.) *Pulse.*—The typical characteristic pulse in every form of scarlet fever, quite from the commencement, is an accelerated one, out of all proportion to the customary ratio with the temperature, and presents considerable tension. This distinguishing feature in mild cases speedily terminates; while in all instances of a severe type it remains. In the ulcerative form we find the suppurative pulse quick, soft, feeble, and attaining 160 to 180. In the malignant type the adynamic pulse full, soft, irregular, uncountable, and becoming gradually imperceptible as the acceleration proceeds.

As convalescence is established the pulse becomes slow, in variation with the previous depressing effect of the scarlet-fever toxin upon the heart muscle.

(vi.) *Tongue.*—If the illness has been of the perambulating variety no indications may be present on the tongue, or, at all events, they may persist for so short a period — which appears to me to be the true doctrine—as to be imperceptible to the medical observer, who may only see the case once, or at most twice, in the twenty-four hours.

But in the ordinary, average, well-marked case the tongue is covered at an early stage with an extensive white coating of epithelium, through which the normal red papillæ protrude, which, peeling off from the tip and edges, has entirely disappeared by the fourth day, leaving a raw-looking, red, fleshy, smooth, swollen condition, commonly termed the strawberry tongue, and absolutely pathognomonic of scarlet fever. As the epithelium is re-formed the tongue assumes its normal appearance, though the papillæ, becoming œdematous, sometimes present a miliary aspect. If, however, the fever is high and delirium present, the tongue may grow dry and fissured, though still abnormally red, glazed, and bare of epithelium. In the malignant variety death usually occurs before the tongue peels; and if death takes place prior to the appearance of the eruption, the diagnosis may involve grave difficulty.

(vii.) *Throat.*—1. In the earliest stage of all sore throats the mucous membrane appears smooth, dry, and glistening, as if all secretion and the superficial layer of the mucous membrane had been scraped off and the surface polished.

2. In the next stage of all cases of scarlet fever, even in the mildest, there is a general uniform redness of the uvula, soft palate, the palatine arches, and the tonsils,—in fact, the appearance is that of an exanthem of the throat, exactly analogous to the exanthem of the skin, and precedes the exanthem of the skin by twenty-four hours.

3. When the disease is more intense these parts present a velvet appearance from the œdema which the exanthem of the throat produces. The colour becomes a deeper red, and involves the whole of the fauces and the hard palate. Small elevations form, arising from swelling of the papillæ, which give the mucous membrane a granular appearance.

4. In most cases the preceding condition is succeeded by swelling of the tonsils, which gradually become covered with minute isolated white dots, occasioned, in consequence of the hyperæmia, by an excess of the normal secretion from the follicles of the tonsils.

5. This secretion may increase to such an extent as not only to appear at the orifices of the follicles, but also by coalescence to form a layer of secretion covering the tonsils, and resembling an ulcerated surface. All the preceding changes usually disappear by the third or fourth day, and the throat by degrees assumes its normal appearance by the end of a week.

6. But when the throat becomes more severely inflamed, as in scarlatina anginosa, the tonsils grow more swollen and ulceration follows, together with an excessive secretion of mucus of an acrid watery character, which includes the whole of the mouth and the nasal mucous membrane, and causes soreness of the nose and the upper lip. Sloughing and gangrene subsequently supervene.

7. At other times abscesses of the tonsils occur, with so extensive a swelling of the uvula and tonsils that regurgitation of fluid takes place through the nose.

8. At a later stage the regions of the parotid, of the submaxillary glands, and the whole of the connective tissue of the neck become enormously swollen, assuming a brawny character which may disperse in a few days, or terminate in abscesses or gangrene.

(viii.) *Glands.*—It is an invariable law of nature that augmented action produces increased growth. Where additional work is thrown upon glands they become either temporarily or permanently enlarged. In scarlet fever two sets of glands are involved owing to the anatomical lesions which affect them.

1. In common with all eruptive fevers, the glands in relation with the lymphatics of the skin, while performing their functions in connection with the eruption of scarlet fever, become somewhat increased in size. Where the eruption is slight and transient they cannot be detected at all; but where it is copious they are readily perceptible, though they never attain the size, hardness, and tenderness which they exhibit in rubella.

2. The lymphatic glands of the throat and neck can be scarcely perceived during the first few days, although from the onset some fulness of the neck may be discerned; but subsequently an enlargement will occur in proportion to the severity of the faucial affection. In all cases of scarlatina anginosa, where the stress of the illness is largely manifest in the throat, these glands suffer from a severe adenitis frequently attended by suppuration,—the acuteness of the inflammation involving the connective tissue of the neck in a brawny swelling, whence suppuration is also liable to arise,—the thin ichorous matter burrowing in various directions, with the production of sloughing of the connective tissue and the skin, and terminating fatally before the close of the second week. In some instances venous hæmorrhage from the involvement of a vein precedes death.

(ix.) *Eruption.*—I have purposely hitherto withheld the description of this symptom, since, in the investigation of eruptive fevers, the "rash" is usually observed first, and a mental diagnosis is at once made, without a full investigation of other equally important symptoms and the period of incubation. This entails a preconceived idea that can only betray the investigator into frequent mistakes, which would be avoided if a patient, painstaking investigation of the whole of the symptoms were instituted prior to a definite conclusion. The mind must be biassed which sees the eruption first. For it is an ingrained prepossession in the medical mind, that a diffuse red rash, followed by desquamation, affords unmistaken evidence of scarlet fever. This notion, however, is contrary to fact, as unfortunately the rash of the Fourth disease resembles so closely that of scarlet fever, that, in certain cases, and in certain stages, no medical man who simply studies the eruption can possibly perceive the distinction.

Another frequent source of error in diagnosis is the inference that the slightness of the illness precludes the suggestion of scarlet fever; while its severity is assumed to be an unfailing indication of that disease. It is certain, on the contrary, that some of the mildest cases of serious illness I have witnessed have been scarlet fever; and it is an established fact that these cases frequently become fatal in consequence of acute nephritis. I have also known the illness occasioned by the Fourth disease assume a somewhat severe type.

In the mildest type of scarlet fever the rash is scarcely visible, forming as it does a mere diffuse scarlet blush, which is so evanescent in character, lasting only a few hours, as to have totally disappeared before the visit of the doctor.

It is usually stated that the eruption of scarlet fever is shown first upon the neck, cheek, and upper arms, and that it does not appear upon the face. But I can testify that the eruption does present itself on the face, less raised in character, perhaps; and from its appearance behind the ears, too, I have little doubt that it also occurs on the hairy scalp. I should say that it commences on the scalp, extends to the face, neck, chest, and gradually downwards over the whole of the body. In further evidence of this statement, I would cite that the earliest desquamation is perceptible on the tips of the ears and on the prolabium of the lips. Certainly the eruption is visible on the forehead and cheeks, while the circle round the mouth stands out white in contrast, and the former regions, in addition, shed a browny desquamation.

The sore throat commences with the other symptoms of invasion. The eruption appears twenty-four hours later, spreads rapidly from above downwards, except on the palms of the hands and soles of the feet, and attains its maximum in three days, when desquamation begins in the same order of process.

The aspect of the eruption from a distance is that of a diffuse, bright brick-red, assuming a darker dusky red when the eruption is intense. On close inspection, however, or with the aid of a magnifying-glass, it is seen to consist of aggregated red papules or pin-heads, with the intervening circles of skin of a normal colour in the first instance, transformed later into an erythema which disappears earlier than the red papules. The papillæ are more raised on the outer surfaces of the limbs, where the skin is naturally thickest, than elsewhere. It is the close aggregation of these papillæ which gives the rash a uniform red appearance, the colour varying from a pale red to a brick red, and the depth of colour being usually in direct proportion to the intensity of the fever. The colour can be pressed out of the skin by the pressure of a finger, and writing with the finger-nail on the skin depicts it in white lines. Hæmorrhagic points appear sometimes in very intense eruptions, and even gangrene. The hyperæmia of the papules may also sometimes entail a miliary eruption, appearing chiefly on the hands and wrists, arising from exudation of serum within the papules. When the skin begins to act, sudamina even may supervene. When the eruption attains its height, œdema of the skin also occurs.

At the termination of the eruption, which takes place in about a week, the skin assumes a yellowish appearance prior to desquamation.

After death no eruption is visible, though, in consequence of exudation in the rete Malpighii, the skin is found to be thickened.

(x.) *Desquamation.* — The hyperæmic condition of the skin, arising from the scarlet-fever eruption, entails an excessive growth of newly formed epidermis, which, on the subsidence of the exanthem, exfoliates, and consequently varies in amount and extent according to the intensity of the eruption. In very thin skins, and in instances where the eruption has been very transient, the peeling would naturally be slight. In these cases I have rarely failed to find it on the tips of the ears and the prolabium of the lips. If the eruption has been severe, peeling commences early on those parts where the eruption first fades; follows the fading immediately; and spreads, in the same order, over the whole of the body. If, however, the eruption has been very scanty, peeling may not be visible anywhere save on the palms of the hands and the soles of the feet, and does not commence in those parts until late.

The desquamation varies in duration according to the preceding eruption, and is usually complete within six or eight weeks, except on the palms and soles, where its cessation is frequently delayed for ten or twelve weeks. The desquamation also varies in extent according to the consistence of the skin in the various regions of the body. When closely observed it is found that desquamation begins around the raised points of the eruption, leaving a hole for the papilla in the centre. These circles coalesce, and the epidermis is shed, varying in character (according to the antecedent eruption, and the region from which it is cast) from a fine white powder to shreds and sheets of considerable size, and in the region of the fingers and toes the shedding sometimes occurs in one piece like the finger of a glove. Partial peeling may take place a second time, and so prolong its period.

(xi.) *Digestive System.*—In addition to the vomiting the bowels become early confined, and diarrhœa also succeeds.

(xii.) *Nervous System.*—In slight cases the nervous system is unaffected, but when the attack is severe the delirium, restlessness, and sleeplessness are very marked, and indicate that the nervous system is profoundly involved by the toxin. Ushered in with convulsions, the convulsions may recur, muscular tremors arise, and coma supervene with hyperpyrexia.

(xiii.) *Urinary System.*—The urine during an early period of the illness presents a character similar to that attending an acute fever, with a diminution or absence of chlorides.

Apart from acute nephritis, which will be discussed under the sequelæ, albuminuria is not infrequent, and occurs occasionally in the first week; usually, however, it does not appear until the third week, and most commonly on or

about the nineteenth day, disappearing in a few days, or as the fever subsides. The persistence of albuminuria for a month or six weeks constitutes a very unfavourable symptom.

(xiv.) *Respiratory System.* — Where chest symptoms suddenly present themselves during scarlet fever, it is not the lung that suffers, but the serous membranes of the pleura and the pericardium — except when acute nephritis occurs, in which case pulmonary œdema is to be expected, and is an ominous symptom.

(xv.) *Generative System.*—There is also, at times, a mucopurulent discharge from the vagina, which, during its continuance, may be a source of infection, and should be watched for.

VII. Varieties.—For convenience of description, and without assigning any fixed lines of demarcation, we may distinguish these varieties, and divide them into the following classes :—

(i.) *Scarlatina Simplex.*—The cases included here are those which are attended by slight sore throat; a characteristic eruption; an increase of temperature, perhaps reaching 102° F.; and a quickened pulse, of 120 to 130. The fever reaches its height on the third or fourth day, and the entire illness is comprised within about a week, without complications.

(ii.) *Scarlatina Anginosa.*—This mostly affects young children. It is attended by an ulceration, commencing in the tonsils, which extends and destroys the neighbouring tissues, with symptoms of septicæmia. An intense eruption accompanies it, which becomes dusky, or even hæmorrhagic. The temperature attains 104° F. or upwards. The pulse becomes very rapid, 150 or 160, and irregular.

These symptoms continue into the second week, attended with delirium, insomnia, and anorexia. Unless improvement here supervenes the disease proceeds into the third week, accompanied by diarrhœa, sweating, pulmonary symptoms, and death.

(iii.) *Scarlatina Maligna.*—The severity of these cases results from the production by the toxin of acute poisoning in the blood, which is followed by death within twenty-four or forty-eight hours, before even local manifestations have had time to arise. The absence of symptoms, together with the rapidly fatal result, may give rise to suspicion of the action of an external poison. There may be no rash, no local affection of the fauces, but the intensest fever, 106° F. or upwards, with an uncountable pulse. Sometimes the nervous depression is so profound that the temperature is subnormal. In less severe cases of an adynamic type the rash and throat are evident, and the patient may live for two or three days longer.

(iv.) *Scarlatina sine Eruptione.*—These are abortive attacks of scarlet fever characterised by their mildness and the complete absence of certain symptoms, such as the rash in some instances, and in others the throat signs. In scarlatina sine eruptione there is occasionally found a well-marked and extensive desquamation.

(v.) *Scarlatina sine Anginosa.*—In this form rheumatism, kidney disease, parotitis, and infiltration of the cervical connective tissue may even occur.

(vi.) *Surgical scarlet fever* ensuing upon wounds, however caused, is generally of a mild type.

(vii.) *Puerperal scarlet fever*, arising immediately before or after parturition, usually presents a form which causes grave anxiety by reason of its fatality, with septicæmic symptoms. At anterior stages the pregnant woman is not more affected by scarlet fever than persons generally.

VIII. Stages.—(i.) *The Period of Incubation.* —If one fact be more certain than another in medicine, it is the limitation of the incubation period of scarlet fever to seven days. In cases where the term is stated to exceed this limit the accurate source of infection has been mistaken, or the cases belong to the class of disease which I have designated a "Fourth disease," and which it is exceedingly difficult to differentiate from scarlet fever.

It is undoubtedly the fact that in occasional instances the period of incubation is less than twenty-four hours; but the greatest number of patients exhibit the disease on the third day, many on the second or fourth, a few on the fifth, while its occurrence on the sixth is extremely rare. It may be regarded, therefore, as final doctrine that the incubation period of scarlet fever never extends beyond a week, and rarely lasts so long. But in estimating the period of incubation it must be remembered that during a time when scarlet fever is prevalent the common sore throats of colds, or cases of simple tonsillitis, occurring in those who have suffered from scarlet fever, are capable of conveying scarlet fever to an individual who has not already been affected. If the patient has been previously attacked these sore throats are regarded as non-infectious, and the sufferers consequently are not isolated, as they should at once be, for three or four days. The interpretation of these cases appears to be this :— There are always a certain number of young people in every community who have tonsillitis several times in the course of the year; and even when they do not suffer from an acute attack, the tonsils are chronically enlarged and full of accumulated secretion, in which the scarlet fever bacillus finds a suitable nidus for development; while, accordingly, the sufferers are themselves protected, the bacilli are able to fertilise and infect the unprotected. I believe that precisely the same process takes place in the causation of "return" cases of scarlet fever. Fresh cases of infection are mixed with convalescents whose throats, not yet restored to a normal condition, provide the congenial soil

for a new invasion of active bacilli, and when these convalescents return home the natural result follows which defeats the force of isolation. When scarlet fever is becoming prevalent I carefully isolate *every* case of sore throat, however slight, and consequently an epidemic has never occurred. I endeavour, moreover, to prevent a recent case being placed near a convalescent, and thus I have never experienced a "return case," although I have allowed boys to return to school or to their homes with impunity. It is further suggested by some authorities that some sore throats, produced solely by exposure to the infection of scarlet fever, are capable of inducing the disease in what are termed second attacks. It may be so: I cannot assert the contrary. But I am quite sure of my previous interpretation, knowing well the facts of those cases which were affected with the oft-repeated tonsillitis, and which caused me trouble.

(ii.) *The Period of Infection.*—Of all zymotic diseases scarlet fever is the least infectious in its early stage. Were it not for this fortunate feature in its natural history it would probably spread as freely as measles or rose-rash. Its most infectious period is undoubtedly during the height of the eruption, with a gradual diminution as the illness wanes. At this stage its powerful capacity of infection is evidenced by the cases occasionally recorded where not only a moment's exposure has sufficed to produce infection personally, but even where a mother, after the briefest exposure, has, without being herself affected, conveyed infection to her child at a distance. In such cases I believe that the sick-room must have formed a hotbed of infection from the absence of a free supply of fresh air.

The question, however, of deepest concern is the duration of the infection. One course only is sound and sure in our present state of knowledge. In slight cases six weeks' quarantine should be imperative; in all other cases freedom from infection should not be certified until all desquamation, all discharges from the eyes, nose, mouth, throat, and abscesses have ceased. It is questionable whether the prolonged period of persistence of infection which is sometimes assigned is not really due to fomites.

Although I have expressed the only safe rule of action, I am far from believing that the duration of infection is at all as extensive as that which is ascribed. I am of opinion, though demonstration is not available at present, that in an average case of scarlet fever without complications, supplied throughout with abundant fresh air, free from contact with recent cases, and with a thorough disinfection of person and clothes, the infection does not endure for half the time we usually assign. I submit the proposition, with clear conviction, that, where disinfection has been complete, and no fomites are present, the prolonged peeling from the hands and feet is not infectious.

When, however, we consider the question of fomites we are struck by the tenacity of infection. Without doubt the disease is readily and frequently conveyed by fomites, and thus all calculations become frustrated. Disused infected rooms, disused clothes folded up in drawers, and long-forgotten toys have caused scarlet fever to start *de novo* months after the previous illness.

With reference to the *recrudescence* of scarlet fever, I am not quite clear that such a process occurs. Nor am I now certain that a *relapse* ever takes place. In former years I thought otherwise; but having of late years attended (and studied those of other observers) cases of scarlet fever preceded and followed by a distinct disease, closely resembling scarlet fever, which I have provisionally designated a "Fourth disease," I am seriously dubious of the recrudescence theory.

(iii). *The Period of Protection, or Immunity from Further Attacks.*—Fortunately one attack, as a rule, confers immunity for life. Where second attacks are recorded, I believe that usually they belong to the species of the "Fourth disease." There are certain rare individuals, however, who are so susceptible to the influence of the poison that they will exhibit some of the symptoms in every conceivable anomalous form whenever they come in contact with the disease. I had one patient who was thus afflicted. Similar instances are found in smallpox. A patient of mine had been inoculated for smallpox; had suffered from confluent smallpox; had been subsequently vaccinated; and yet eventually died of smallpox poisoning at the age of seventy-five, without eruption, caught from one of his parishioners with whom he sat reading. On the twelfth day acute fever showed itself, with severe backache; and on the ninth day of a severe illness, attended with delirium, he died. Such instances, however, are so rare as to be unique.

IX. Complications. — The complications of scarlet fever are numerous and various, and even when not fatal they frequently entail permanent damage upon organs, or lifelong ill-health. No period of the disease is free from complications. At one time they arise suddenly, at another their advent is too insidious to attract notice.

(i.) *General Diseases.*—Rheumatism forms one of the earliest and most frequent complications. It affects chiefly the smaller joints, such as the fingers, hands, and wrists; suppuration is sometimes produced in the joints. Its appearance usually occurs during the first week, and elder children and adults rather than young children are affected.

(ii.) *Diseases of the Nervous System.*—Scarlet fever is frequently complicated with severe

central and spinal symptoms, which may arise from hyperæmia, or blood-poisoning, or meningitis.

(iii.) *Diseases of the Digestive System.*—1. Ulcerative Stomatitis.—In all descriptions of scarlet fever, when complications appear, their tendency is to assume ulcerative and pustular forms. After an attack of the mildest type of scarlet fever I have seen ulcerative stomatitis supervene. From the condition of the throat in scarlatina anginosa the inflammation spreads to the mouth; the gums become spongy, bleed easily, and ulcerate. In severe cases the inflammation proceeds to Noma, with all its attendant symptoms of salivation, sloughing, and the shedding of the teeth; and confines itself to young children entirely. From the resulting exhaustion, and the pain in taking food, sufficient nourishment is impracticable, and great debility thus ensues.

2. Liver.—Changes in the condition of the liver are also present, consisting of an albuminoid infiltration of its secreting cells, produced simply by the severity of the fever.

3. The *intestinal* mucous membrane becomes intensely congested, and occasions severe diarrhœa.

(iv.) *Diseases of the Circulatory System.*—Pericarditis and endocarditis are occasionally present, with or without rheumatism; and those changes in the cardiac muscle where the fibres assume a granular capacity, which form the usual result of high fever. Thrombosis is not unusual, and results from septicæmia. The blood is of a dark colour, watery in character, with an excess of white corpuscles.

(v.) *Diseases of the Respiratory System.*—Bronchial catarrh and pneumonia are not uncommonly found on search, especially in cold weather. Œdema of the larynx, and acute pulmonary œdema, when the kidneys are involved, are especially to be dreaded.

(iv.) *Diseases of Serous and Synovial Membranes.*—Effusion into the pericardium, pleura, and joints is very liable to occur. It supervenes insidiously, and tends to terminate in suppuration.

(vii.) *Diseases of the Urinary System.*—1. Albuminuria.—As shown in a daily examination of the urine in each case, simple albuminuria, usually without casts, may commence as a mere trace during the first few days, and generally speaking implies little importance—in fact it frequently means improper feeding in the early stage of scarlet fever, or unwise exposure.

But it most frequently arises in the same character during the third week—about the nineteenth day—and, unless very marked in quantity, gradually disappears as convalescence proceeds. In some instances it is not manifested until the patient leaves his bed. Most generally it occurs when constipation exists, and, where it persists, a prolonged period in bed must be required before its final disappearance.

2. Acute nephritis is usually occasioned by the toxic effect of the scarlet-fever poison, though sometimes it is produced by chill. Its onset is sudden, and is accompanied by headache, vomiting, rigors, acute fever, drowsiness, diminished secretion of urine, frequent micturition in small quantities, hæmaturia, and casts. After a day or two the skin becomes dry, anasarca appears, and the temperature varies. Increased arterial tension is found, with a quick pulse. Mahomed described a pre-albuminuric tension of the arteries. As the hæmaturia lessens all the symptoms abate, and the flow of urine increases.

There is another type of case with similar commencement, but with less marked symptoms, and without hæmaturia. This type usually supervenes towards the end of the third week. It occurs as frequently, if indeed not more frequently, in mild as in severe attacks, in consequence of the former receiving insufficient care. It either terminates in recovery, or leaves permanently damaged kidneys, or ends in death from uræmia or acute pulmonary œdema.

(viii.) *Diseases of the Organs of Special Sense.*—1. *The Ear.*—Unless there be a family predisposition to *otitis*—which, in my experience, is very frequent even in those in affluent circumstances, and very disastrous in its consequences—its occurrence is usually manifested in severe cases only. It generally presents itself during the first five years of life, decreases in each subsequent year, and forms the most frequent complication of scarlet fever. Otitis, in these instances, is commonly an extension of the faucial inflammation; varies from a simple earache to an acute otitis media, and may be followed by mastoid abscess, and even meningitis. Subsidence may take place within a few days or weeks; or its duration may be extended for months or even years.

2. *The eye* is rarely involved, and then only with a slight conjunctivitis in the early stage. But in the delicate and cachectic the eyes may be seriously implicated during the suppurative period in a general ophthalmia, with corneitis, where the home surroundings are those of destitution and overcrowding; and with retinitis when the kidneys are involved.

(ix.) *Diseases of the Lymphatic Glands.*—In addition to the state of the glands previously described as occurring during the height of scarlet fever, suppuration of the cervical glands may ensue during convalescence.

(x.) *Diseases of the Supporting Tissues.*—1. *Cellular Tissue.*—Inflammation of the greater part of the areolar tissue of the neck and parotid region may occur, tending to suppuration which may burrow in all directions, and produce formidable abscesses, or sloughing of tissues.

2. *Bones.*—Periostitis and necrosis may arise at a later stage of the disease.

(xi.) *Diseases of the Integumentary System.*—An infinite variety of affections of this system may be produced, ranging from herpes labialis to severe boils. The most frequent is eczema, which mainly occurs at those orifices from which acrid or pustular discharges have flowed—round, for example, the ears, nose, and mouth. The inflamed oozing eczema is apt to become pustular, and to extend from these centres.

(xii.) *Anæmia* and a protracted period of general debility and ailing are often the sequelæ of a slight attack in the delicate, or of a severe attack in the strong, and require attention for months or years before the usual health is recovered.

X. Relation to other Diseases.—(i.) *Measles.*—It has been stated by some medical writers that scarlet-fever epidemics tend to follow outbreaks of measles; but this view, after a lengthened and carefully analysed experience, I am unable to endorse. The relation, however, which has been observed between scarlet fever and measles is completely explicable where rubella and the Fourth disease are substituted. These forms of disease are so frequently concurrent or consecutive that their confusion with measles and scarlet fever, or with rubella and scarlet fever, is both prevalent and facile.

(ii.) *Diphtheria.*—Although diphtheria may occur at any stage of scarlet fever, its prominent period of appearance is that of convalescence. It may follow the mildest as well as the severest form of scarlet fever, and seems to be incidental to cases treated in hospital, where it apparently clings to certain hospitals and certain wards. When it occurs it usually arises in groups of cases in the various wards which possess no intercommunication. Dr. Caiger, whose special experience has been most extensive, says:—"Such outbreaks have not infrequently arisen in seasons characterised by a high degree of atmospheric humidity, dependent upon previous rainfall and consequent dampness of soil. The incidence of the disease is for the most part greatest in wards surrounded with grass, or other vegetation growing in a clay soil; indeed, the moisture-retaining character of the actual surface would seem to be of greater importance than the subsoil drainage, whether natural or artificial." He furnishes the mortality in cases of diphtheria following scarlet fever as 58·3 per cent; and this high percentage is due to the special tendency of the disease to affect the respiratory passages.

Scarlatina from diphtheria may at any time arise; but this course is rarer than the reverse one.

XI. Diagnosis.—From the preceding discussion it will be readily understood that this disease presents the most serious difficulty in diagnosis. In its mildness or in its infinite vagaries many days may elapse before a definite judgment can be formed; and at times, indeed, the certainty of diagnosis may appear to be impracticable, unless another case arises from it with an accurate period of incubation and well-marked symptoms. Even in typical instances I have myself long felt doubtful until some days have elapsed, and characteristic symptoms have appeared in their natural course. In face of these difficulties, and in regard to the serious consequences which may ensue from erroneous diagnosis, I would suggest that the only sound rule is that of the game of whist,—"When in doubt play trumps"! and hence I propound the maxim that the existence of doubt should imply the presence of scarlet fever, on the ground that, if the assumption prove incorrect, less harm will usually have been produced by reason of the scrupulous care that will thus have been exercised. This course, however, is not always justified; for a medical friend not long since informed me that twenty-eight patients had been sent to a scarlet fever hospital in one year, the whole of whom proved to be free from that disease. I have also a series of cases in my hands, recorded by a most accurate observer, but I am unable to make use of them now, beyond saying that six patients were admitted into a fever hospital as scarlet fever who were proved to be suffering from the Fourth disease, and subsequently caught scarlet fever when in hospital; and six other patients were admitted suffering from scarlet fever, who caught the Fourth disease while in hospital from some of the previous set.

In presence of such grave mistakes a serious burden of responsibility is involved in the accurate diagnosis of these cases of illness, but still more so on one who presumes to instruct others in their elucidation.

In now considering the question of diagnosis, I would urge, *in limine*, that the physician who bases his diagnosis primarily upon the "rash" is hopelessly lost in confusion. I even venture to make the wider statement, that a physician who commences his investigation of these exanthemata by observing the rash chiefly, is involved in the same confusion, since, in the interpretation of the remaining symptoms, he will become so biassed by his foregone conclusion that no clear judgment will be practicable.

In a typical case of scarlet fever diagnosis is comparatively easy, and for the purpose of refreshing the memory I will briefly enumerate the symptoms. A sudden onset of acute symptoms, with headache and vomiting, accompanied by a marked sore throat, attended by high fever and an exceedingly quickened pulse, followed in twenty-four hours by a minutely punctate eruption, which avoids the circumoral region, and spreads from above downwards until the entire body is uniformly covered. The tongue peels on the fourth day of the illness, which is followed by a general desquamation of

the skin from above downwards, commencing on the face, lips, and ears. With this series of symptoms before him even the comparatively inexperienced can find no difficulty in diagnosis.

The diseases with which scarlet fever is mostly confounded must now be considered:—

(i.) *Acute Tonsillitis.*—In the early stage of this disease, and when scarlet fever is prevailing, accurate diagnosis is well-nigh impossible, and therefore quarantine is imperative. The disease, however, rarely commences suddenly with vomiting; the eruption, when present, is merely an erythema, and not a punctate eruption. At first the tonsillitis is unilateral. The tongue, though coated, does not peel, and the skin does not desquamate.

(ii.) *Erythema.*—At an early period, when diagnosis is of most importance with a view to isolation, the rash in these cases is limited to the neck and a portion of the trunk; it does not appear on the extremities, and it spreads in a very irregular manner.

(iii.) *The Fourth Disease.* — Provisionally merely *numbered*, until a distinguishing name is attached to it.

Definition.—A zymotic disease characterised by an exanthem, scarlatiniform in character, which is usually the first noticeable symptom. It is a diffuse, not patchy, rosy-red eruption from the onset, and, however intense the eruption may be, the sensation of heat to the touch is usually slight. It is generally followed by desquamation, which bears, however, no relation to the intensity of the eruption.

It is mostly preceded by no symptoms, though where the attack is sharp there may be some headache, drowsiness, and tiredness for a few hours before the eruption is manifest. Its season is mainly the spring. The incubation period is prolonged even to three weeks. Its duration of infection is about a fortnight. The strawberry tongue is never present. It affords no protection against measles, scarlet fever, or rose-rash.

History.—It was not until towards the close of the seventeenth century that scarlet fever ceased to be confounded with measles, and at the close of the nineteenth century rose-rash (rubella) was still confused with measles and scarlet fever. At the opening of the twentieth century, another disease has been distinguished, isolated, and classified, which, while greatly resembling measles, rose-rash, and scarlet fever in many characteristics, is quite distinct from them all, and an attack of any one of these diseases does not protect from an attack of the other.

Etiology.—Enough is known at present to speak of the age and sex incidence. But the various epidemics I have seen occurred in December, February, March, April, and one single case in June. It is an infectious disease which, like scarlet fever, occurs in smaller epidemics than measles or rose-rash, probably on account of its being, again like scarlet fever, less infectious at the outset.

Symptomatology.—See pages 40-44, where its distinguishing characters are set out side by side with those of scarlet fever and rose-rash. Also the original article may be consulted in the *Lancet* of July 14, 1900, "On the Confusion of Two different Diseases under the name of Rubella (Rose-rash)," and a paper by the medical officer of health for Southport, "On the Fourth Disease," and published in the *Journal of State Medicine.*

To sum up the leading characteristics which show that this disease is distinct from measles, rose-rash, and scarlet fever, I will formulate them as follows:—

1. That although the resemblance of the Fourth disease is so close to scarlet fever in many of its features, it cannot possess any affinity with that disease, inasmuch as both diseases occurred concurrently in the same epidemic.

2. That some of the sufferers had BOTH diseases in the same epidemic, one patient having scarlet fever followed by the Fourth disease, and several having Fourth disease followed by scarlet fever.

3. That, although the Fourth disease has been confused with rose-rash, and regarded as a mere variety of rose-rash, this conclusion is fallacious, since nearly one-half the cases in one of my epidemics had already had rose-rash within a year or two, which, according to Cullen's established law, is incredible.

(iv.) *Rubella.*—*Vide* p. 16.

THE DISTINGUISHING CHARACTERISTICS BETWEEN RUBELLA (ROSE-RASH), THE "FOURTH DISEASE," AND SCARLET FEVER.

Rubella (Rose-Rash).	The "Fourth Disease."	Scarlet Fever.
1. *Premonitory Symptoms.* — In many instances none; no headache; no vomiting; no catarrh; no cough; but frequently sore throat. If the attack be severe, some malaise, anorexia, and drowsiness will exist.	1. *Premonitory Symptoms.* — In many cases none, even with a copious eruption; neither headache, nor vomiting, nor catarrh, nor cough, but frequently slight sore throat. If the attack, however, be severe, there may be pronounced malaise for some hours, with headache, anorexia, drowsiness, chilliness, and even considerable backache.	1. *Premonitory Symptoms.*—If the attack be slight the patient merely feels tired, and usually complains of some amount of sore throat, headache, and chilliness. There may, however, be considerable malaise, with a genuine sense of illness, accompanied by some vomiting.

Characteristics between Rubella, the "Fourth Disease," and Scarlet Fever—*continued.*

Rubella (Rose-Rash).	The "Fourth Disease."	Scarlet Fever.
2. *Sensations of Illness.*—Even with a full eruption as intense as in measles the patient usually states that he does not feel ill, although there may be other indications to the contrary.	2. *Sensations of Illness.*—Where the eruption is slight there is no illness of any kind, and where the eruption is copious the feeling of illness is sometimes scarcely apparent, although I have seen boys really ill from this disease.	2. *Sensations of Illness.*—In slight cases there is no apparent illness, but I have never seen a case with a severe eruption where the patient was not really, and also sensibly, very ill.
3. *The Temperature.*—This varies from normal to 103° or 104° F.	3. *The Temperature.*—This varies from 98·4° to 103° or 104° F.; but even with a very extensive rash the temperature is not necessarily high.	3. *The Temperature.*—This varies from 99° to 106° F., but is never increased in the usual ratio to the pulse. A full rash always means a high temperature.
4. *The Pulse.*—This is normal or slightly increased in frequency, but always bearing a ratio to the temperature.	4. *The Pulse.*—In slight cases the pulse is normal, and where the case is a well-marked one its rate is quickened, while still bearing a ratio to the temperature; that is to say, where the pulse is accelerated the temperature is raised in a proportionate degree.	4. *The Pulse.*—Even in slight cases the pulse is accelerated, and in severe cases very greatly quickened, and always out of all proportion to the height of the fever; that is to say, even with a temperature only just above normal (99° F.) the pulse will be very rapid (120).
5. *The Tongue.*—This is clean or slightly furred, and never coated with a thick white fur, which peels on the fourth day.	5. *The Tongue.*—The tongue is clean or slightly furred, and never coated with a thick white fur, which peels on the fourth day, leaving the tongue raw.	5. *The Tongue.*—If the case be slight there may be no early signs, though the tongue peels on the fourth day. But in a well-marked case the tongue is early coated with a thick white fur which, peeling off from the tip and edges on the fourth day, gradually leaves a raw, red tongue, commonly termed the "strawberry" tongue.
6. *The Throat.*—The fauces look dry, with a dark, motley, red hue.	6. *The Throat.*—The fauces are usually swollen and reddish, assuming a velvet appearance, but this condition bears little relation to the extent of the rash.	6. *The Throat.*—The appearance of the fauces may vary from the most insignificant affection to an intense dusky redness, with marked swelling, showing sometimes white spots of inspissated secretion; and the severity of the throat affection bears usually a distinct relation to the skin eruption.
7. *The Glands.*—The lymphatic glands throughout the body are enlarged, tender, and hard, like peas, notably the posterior cervical, the axillary, and the inguinal.	7. *The Glands.*—The lymphatic glands universally are enlarged, hard, and tender, and feel like peas, though less manifest than in rose-rash. Those mainly affected are the posterior cervical, the axillary, and the inguinal.	7. *The Glands.*—The lymphatic glands of the throat and neck can scarcely be detected during the first few days; but subsequently they may be enlarged in proportion to the severity of the faucial affection. This, however, creates no difficulty, as the axillary and inguinal glands are not so involved as in rose-rash.
8. The *eruption* is usually the first noticeable symptom. Its appearance is that of minute rosy red dots, not patches. It shows itself first behind the ears and on the scalp and face, especially on the oral circle; from these situations it extends to the neck and the chest, and ultimately covers the entire body. The minute dots become larger and gradually coalesce, forming patches of the bat's wing pattern, which so extend and alter in colour as to be indistinguishable from measles. In other cases the spots become so diffused that the rash, in patches, resembles the eruption of scarlet fever; but never, in this disease, is this appearance manifest from the commencement.	8. The *eruption* is usually the first noticeable symptom, and will cover the whole body with a considerable diffuse rash in a very few hours. The hue is a bright rosy red, and the eruption is raised somewhat from the surface of the skin. The sensation of heat of the skin to the touch, even where the rash is very full, is much slighter than in scarlet fever.	8. The *eruption* is diffuse, dusky red, papular in character, and originates behind the ears. It presents a goose-flesh appearance. It does not occur in isolated dots at any stage; nor in patches which are raised and have well-defined margins. It appears early about the clavicles and on the chest and the covered parts of the body. The rash is rarely so full at an early period as in the "Fourth disease," and the skin is markedly burning to the touch.

Characteristics between Rubella, the "Fourth Disease," and Scarlet Fever—*continued.*

Rubella (Rose-Rash).	The "Fourth Disease."	Scarlet Fever.
9. *Desquamation.*—There may, perhaps, be a little branny desquamation, but frequently none occurs, and certainly the pin-hole description is not found.	9. *Desquamation.* — The desquamation may be slight, or as complete as possible, even extending to a general peeling of the hands and feet. But the desquamation bears no relation to the intensity of the eruption, for it often happens that a very full eruption may be followed by little or no desquamation, and that which does occur disappears in a week or two. On the other hand, a full eruption may be attended by a general peeling as free as in the worst cases of scarlet fever, but mostly in small scales rather than in flakes or sheets. A slight rash is usually accompanied by little or no desquamation. But I have never seen a case of scarlet fever with a full eruption where the desquamation did not occur eventually in sheets, the process lasting many weeks. If a series of cases be observed, these abnormalities will be very apparent.	9. *Desquamation.* — The desquamation always bears a ratio to the extent of the eruption. A copious eruption signifies a free desquamation, while a scanty eruption is followed by a sparse peeling, which, however, does not cease for many weeks. It commences invariably by a peeling of the tongue on the fourth day, which extends to the lips and is followed by peeling of the face and behind the ears; one of the easiest places in which to detect the desquamation early is the ear. The desquamation occurs in pieces or shreds rather than scales, and is very profuse about the hands and feet, lasting for many weeks. At the commencement of the peeling circles of desquamation are formed around the raised papillæ, though I have once seen this condition in the "Fourth disease" where the peeling was excessive
10. *The Kidneys.* — They are rarely affected, and then only with a trace of albumin.	10. *The Kidneys.* — These are rarely affected. Where they are involved the condition is probably that only of the albuminuria of adolescents.	10. *The Kidneys.* — Albuminuria is very frequent. The liability to acute nephritis is very decided unless the treatment be appropriate.
11. *The Eyes.*—The conjunctivæ are pink-red and suffused.	11. *The Eyes.*—The conjunctivæ are pink and suffused.	11. *The Eyes.*—Normal.
12. Its *season* is spring and summer.	12. Its *season* is spring and summer.	12. Its *season* is autumn and winter.
13. The *incubation period* is usually 18 days, but with a range of from 9 to 21 days.	13. The *incubation period* has a probable range of from 9 to 21 days.	13. The *incubation period* is usually from 2 to 3 days, but with a range from a few hours to 7 days; it very rarely extends over the fifth day.
14. *The Course of Illness.*—The symptoms, however severe, disappear in a few days, leaving comparatively little feeling of illness; where the eruption is slight there may be no illness whatever.	14. *The Course of Illness.*—The symptoms, however severe, disappear in a few days, leaving comparatively little feeling of illness.	14. *The Course of Illness.*—The illness gradually subsides in from 4 to 7 days. Desquamation commences as eruption fades, and continues for 6 or 8 weeks or more, and lasts longest on the hands and feet.
15. *The Period of Infection.*—I do not know any illness which is more infectious in its earlier stage, even before any symptoms are manifest. It hence results that schools suffer to so great an extent from the disease when once it has found entrance. The infection is diminished at a later stage.	15. *The Period of Infection.*—Infection is not very probable in the earliest stages. At a later period, even while desquamation is taking place, the possibility of infection only continues for 2 or 3 weeks, provided the usual precautions have been carefully adopted.	15. *The Period of Infection.*—This disease is the least infectious of any illness during its early stage. It therefore allows time for quarantine and isolation, and thus can be controlled, so that an epidemic may be prevented more readily than in any other infectious illness. After the first 48 hours the infection is very powerful, but I am not prepared to pronounce upon its duration. Until this can be ascertained the only safe rule is the assumption that it may last as long as desquamation itself, although I am quite clear that this is inaccurate.
16. *Protection.* — The attack affords no protection against measles, the "Fourth disease," or scarlet fever.	16. *Protection.*—The attack affords no protection against scarlet fever or rose-rash.	16. *Protection.*—An attack affords no protection against the "Fourth disease" or rose-rash.

Characteristics between Rubella, the "Fourth Disease," and Scarlet Fever—*continued.*

Rubella (Rose-Rash).	The "Fourth Disease."	Scarlet Fever.
17. *The Duration of Infectiveness.*—From 10 to 14 days where efficient disinfection is in force.	17. *The Duration of Infectiveness.*—From 10 to 14 or even 21 days where efficient disinfection is carried out.	17. *The Duration of Infectiveness.*—From 6 to 8 weeks or more, *i.e.* when the desquamation has ceased. But I am far from believing that the infection endures so long after efficient disinfection, though at present I can adduce little proof.
18. *Sequelæ.*—Practically none.	18. *Sequelæ.*—Practically none, but I have seen the submaxillary glands enlarged.	18. *Sequelæ.*—Nephritis; suppuration of the submaxillary, lymphatic glands and others; otitis; rheumatism; endocarditis.
19. *Termination.*—Usually complete recovery in a fortnight.	19. *Termination.*—Usually complete recovery in a fortnight.	19. *Termination.*—Usually complete recovery ensues, but sometimes convalescence is prolonged on account of the sequelæ; but the disease shows a high mortality in the very young.
20. *Treatment.*—The patient requires about 5 days in bed, followed by 3 days indoors; then about 6 days in the fresh air; and after complete disinfection he may safely mix with others. *Abortive* cases of rose-rash are frequent, and are responsible to a large extent for the spread of this disease. It is difficult to distinguish them, as no actual illness occurs. 1. *Pink eyes.*—A group of cases of epidemic roseola may occur, which exhibit no symptoms that I have yet ascertained except pink conjunctivæ. And these cases are capable of passing the illness on to others, and are immune against a subsequent attack themselves. 2. There is another group of cases of epidemic roseola which I believe—but I cannot at present advance beyond belief, for I have not yet satisfied myself by actual proof—may occur without showing any symptoms beyond slight feverishness and enlargement of the lymphatic glands throughout the body.	20. *Treatment.*—The patient may be permitted to get up on the fifth or sixth day, or as soon as his strength permits, irrespective of the desquamation and without danger from sequelæ. He then requires 3 or 4 days indoors, followed by 5 or 6 in the fresh air, and may safely join his schoolfellows at the end of from 14 to 21 days, notwithstanding desquamation, provided the disinfection has been complete.	20. *Treatment.*—Every case of scarlet fever, however slight, requires 21 days of absolute confinement to bed. The patient should be clothed in a flannel night-shirt, and the skin daily greased with carbolic or eucalyptus oil. No food should be given for the first week except milk and farinaceous food, however mild the illness, in order to guard against nephritis. The patient should not be permitted to join his friends for 6 or 8 weeks; but I do not think it essential to isolate cases until all desquamation has ceased from the hands and feet, for this process sometimes occupies several additional weeks. I have acted on this assumption for many years without harm, even transferring boys to their own homes. Of course, complete disinfection is imperative.

(v.) *Measles.*—A universally confluent eruption of measles, which, however, is very marked on the face, and so should not mislead, may exceptionally assume an appearance resembling scarlet fever. But the earliness of the eruption of scarlet fever, without the preceding catarrhal symptoms of measles, and the characteristic tongue of the fourth day, followed by general desquamation, should remove doubt. The presence of Koplik's spots on the mucous membrane of the mouth and palate may also assist in the diagnosis.

(vi.) *Smallpox.*—The sharply defined individual spots, which shade off gradually into an erythema, should guide the diagnosis, but can only induce error at the very early stage. The severe backache of smallpox should further assist.

(vii.) *Erysipelas.*—The distinction on this point lies in the fact that in scarlet fever, besides the other characteristic symptoms, the rash presents the punctate appearance, while in erysipelas the surface of the eruption is not elevated, and marked œdema of the connective tissue arises, with the formation of vesicles. In scarlet fever the desquamation may occur in places where no antecedent eruption has appeared, but this never happens in erysipelas.

(viii.) *Diphtheria.*—Scarlet fever, with a sloughy-looking exudation on the fauces, may be mistaken for diphtheria when accompanied by an erythema of the skin. Here again it is simply an erythema and not a punctate eruption. This, besides being merely transient, is usually restricted to the neck and trunk, while the extremities remain unaffected.

(ix.) *Influenza.*—An erythema may occur at the onset.

(x.) *Desquamative Eczema.*—At the commencement of the illness general symptoms are frequently severe, and the skin red and œdematous, accompanied speedily by minute vesicles, which may resemble a miliary eruption or sudamina.

XII. Prognosis.—The prognosis of scarlet fever is always uncertain. As a rule the disease is one of the mildest of the exanthemata; but its prognosis, even here, is dubious on account of the numerous sequelæ which may supervene and jeopardise life. Alert observation of every sign, therefore, should form the physician's course, and prediction had better be avoided.

The prognosis is *favourable* when the onset is gentle, the appearance of the rash early and diffused; when the throat affection is not severe, the cervical lymphatic glands not seriously involved, the increase of temperature and pulse moderate, and when temperature and pulse fall as the eruption disappears. Slight rheumatism and albuminuria do not add materially to the gravity of the disease.

Prognosis, on the contrary, is *unfavourable* under the following circumstances:—A sudden onset, with vomiting and delirium; severe involvement of the throat, the nose, and the air-passages; a copious rash of dusky red colour passing into a livid hue; when the temperature rises above 104° F., which continues into the third week; a pulse above 130, small and thready; a very pronounced glandular enlargement; severe nervous symptoms, such as coma, convulsions, restlessness, sleeplessness, and continued delirium; profuse vomiting and diarrhœa; the formation of abscesses in the cellular tissue, glands, and joints; acute nephritis, with excessive hæmaturia, albuminuria, scanty urine, and dropsy; the involvement of the serous membranes; severe affections of the middle ear; and the occurrence of that malignant form, with pronounced angina and intense febrile course, which proves fatal, as no other disease does, in so brief a period and with such distressing symptoms.

Epidemics vary profoundly, and no epidemic should be regarded as benign; for, in certain places and in certain individuals, the reverse result is sometimes found. The season appears to exercise comparatively little influence. The only effect which poverty or opulence seems to possess depends apparently upon the medical aid and nursing which can be secured, though personal predisposition outweighs all other considerations. Sex shows no influence, while to age, next to idiosyncrasy, must be attributed the greatest weight. The case-mortality, preceded by symptoms of septicæmia, is increased enormously, attaining over 50 per cent, if the attack occur during the puerperal state, and particularly if it occur close to the date of parturition, either in precedence or succession. Those states of health, too, which are described as "delicate" and "cachectic" exert a most unfavourable influence.

XIII. Mortality.—Scarlet fever is the most uncertain of all zymotic diseases in relation to mortality. Different outbreaks widely vary in this respect. During the last fifty years the mortality has diminished by about 75 per cent, and this diminution is due to various causes. One cause, no doubt, is its lessened virulence; another the provision of isolation hospitals.

But the mainly effective cause has been the increased care bestowed by many parents upon their children at the nursery age, where the mortality has proved to be 18·8 per cent. The number of unprotected children at the school age is consequently greater. Schools, accordingly, suffer more severely from all the zymotic diseases, though the mortality is considerably lessened, the death ratio being only 3 per cent in scarlet fever.

It would be hazardous to predict that the present benign character of this disease will continue, and that a wide and fatal diffusion of the infection at some time may not occur.

The mortality reaches its maximum in the third year, and the chance that an attack will terminate fatally is highest in infancy. The results of statistical inquiry clearly show—independently of the fact that a large proportion of persons never contract the disease—that the longer an attack is deferred the less likely is its occurrence; and further that, even supposing it to happen eventually, the less probable is its fatal character. In recent statistics of mortality it is proved that from one to five years of age the mortality is about 18 per cent; between five and ten years it decreases to 5·5 per cent; and from ten to fifteen years to 2·5 per cent. From this date it remains practically the same until the quinquennium thirty to thirty-five years of age, when it reattains a percentage of 6·2.

From the previous description of the mild and severe types of this disease, it must not be inferred that the mortality in the former cases is insignificant, and in the latter frequent; such a deduction is quite unwarranted. In fever hospitals, where the severe cases are found, and mild attacks almost unknown, the inference may hold; but certainly the general truth upon the subject is not thereby expressed. Some time ago, for example, an epidemic of scarlet fever occurred in a neighbouring primary school. On its cessation I asked the master how the children had fared, and whether any deaths had resulted. The answer was "five"; and, on closer questioning, I ascertained that in every fatal instance the attack had been so slight that the children had shown no symptoms of scarlet fever, and had accordingly attended school throughout, until it became manifest that their kidneys were seriously, and, as it proved, fatally involved.

XIV. Case-Mortality.—The fatality of the

disease varies in different epidemics, and at the various stages of the same epidemic. It shows a range of 3 to 30 per cent of attacks, with a probable average of 8·5 per cent. The isolation hospitals not only limit the extension of an epidemic, but concurrently reduce the case-mortality. For instance, the case-mortality in the isolation hospitals of the Metropolitan Asylums Board in 1890, with a total number of 10,343, amounted only to 2·97 per cent.

XV. Pathology.—In this zymotic disease the tissues mainly involved are those of the skin, the throat, and the kidneys; but it is not clear whether the true nidus of the streptococcus is the blood or the tissues mentioned. That the organism develops freely in the throat is evident; but as scarlet fever may exist without an eruption or sore throat, and may become fatal, as in scarlatina maligna, prior to the appearance of either of these symptoms, it would seem to be more probable that the streptococcus attacks the blood itself.

1. The characteristics of the eruption on the skin are hyperæmia and œdema of the superficial layers of the corium. The hyperæmia causes a rapid growth of the cells of the epidermis in the rete Malpighii, and their continued reproduction entails the desquamation, which is, of course, most copious where the rash has been most intense.

2. In the throat the mucous membrane is deeply hyperæmic, which leads at first to an increased secretion of the follicles, afterwards to an exudation of lymph, and at a later stage the mucous epithelium gives way, owing to the œdema, or to the intensity of the inflammation, with the formation of an ulcer. As the inflammation progresses and the tension increases, small foci of pus arise in the substance of the tonsils. Decay of the mucous membrane, with sloughing, follows, the lymphatics and submaxillary glands become involved, and abscesses ensue.

3. In the early period of involvement of the kidney there usually occurs a fibrous and hyaline degeneration of the minute arteries and Malpighian tufts of the cortex; while the nuclei of the epithelium covering the tuft and lining the Malpighian capsules are augmented and produce the condition known as glomerulo-nephritis. There also appears a parenchymatous nephritis in consequence of the epithelial cells lining some of the convoluted uriniferous tubules becoming swollen, granular, and opaque.

The kidney is hyperæmic, the capsule strips easily, leaving a bleeding surface; and usually, in the next stage, this viscus assumes the form of the large white kidney.

The kidney subsequently diminishes in size, especially the cortex, and the capsule becomes more adherent. As the disease progresses interstitial nephritis ensues with a corresponding degeneration of the parenchyma. Contraction then takes place, and gradually the contracted granular kidney is developed.

Other changes occur in the liver, pancreas, spleen, salivary glands, and intestines; these modifications are observable in all diseases accompanied by high fever, and consist in inflammatory hyperæmia and proliferation.

XVI. Treatment.—In a disease exhibiting so infinite a variety of types, attended by ever-varying symptoms, and involving such endless complications, it will be readily understood that the treatment must be equally diverse. No treatment is at present known that invariably disarms the poison at its onset. We can only entertain the hope that an antitoxin may be discovered that will prove equally efficacious in this fell disease as the antitoxin in diphtheria; or preferably still, that *prevention* may be secured by inoculation.

The precepts of our great master Hippocrates should especially guide our treatment when he enjoins: "To my mind he is the best physician who knows beforehand what is going to happen. By penetrating into, clearly describing the present and the future maladies of his patients, and explaining symptoms which they omit to state, he will gain their confidence." The substantial differences of symptoms and severity manifested in scarlet fever must indicate its treatment. At one time the attack is exceedingly mild, requiring care and forethought rather than treatment; at others, terribly malignant, with a fatal result before any effective treatment can be adopted; while every variety of description may present itself between these two conditions.

The treatment must therefore depend upon the nature of the disease itself, the constitution of the epidemic, and the idiosyncrasy of the individual.

(i.) *Prophylactic.*—1. Quarantine.—The first essential requirement in legislation dealing with infectious diseases should be the provision of single rooms where doubtful cases can be quarantined until a definite decision upon the nature of the attack is possible. In scarlet fever an accurate diagnosis is frequently impracticable until the fourth day. The retention of such cases in their homes for this period is unwise; while their transfer to a scarlet fever ward on mere suspicion, excited by fear of the Notification Act, is iniquitous.

2. Isolation.—The stringent isolation of an accurately diagnosed case is the next important step, both on account of the patient's own welfare and the protection of the community. This isolation of the sick should extend to his nurse and attendant.

In a private house the most suitable place for the patient is usually the highest story. The isolation should be as vigorous and complete as possible; and no visitors should be permitted

to enter the sick-room. Isolation should continue until desquamation ceases on the body and limbs, that is, for a period of six to eight weeks. In cases of peeling from the palms of the hands and the soles of the feet, which so frequently endures for three or four months, complete isolation is not necessary.

3. The primary requirement in the treatment is an abundant supply of *fresh air*, without draught. The room should contain 2000 cubic feet of air space, and if other cases are treated in the same room, a floor area of 12 by 12 feet, or 144 square feet. In cold weather an open fire should be maintained, with hot-water pipes where necessary, sufficient to raise the temperature not higher than 60° Fahr. The windows should, if possible, be open night and day, varying according to the wind and weather, but without placing the patient in a draught. Where this avoidance of draught is impracticable, a window in an adjoining room or on an adjacent staircase may be available, and should never be closed day or night, as well as the door of the bedroom. The old method of hot rooms and close atmospheres has, I trust, been finally banished in the treatment of zymotic diseases.

4. Bed and Bedding.—A three-foot-wide bedstead with a wire mattress is the most convenient for nursing, on which should be placed a horse-hair mattress. Blankets, sufficient only for protection from cold, are preferable to eider-down quilts, which are too impervious. A thin flannel night-shirt, the length of the body, should be worn throughout the illness.

5. All unnecessary *furniture and hangings* should be removed from the room, together with the contents of wardrobes.

6. The *daylight* should be ample, so long as no glare falls upon the patient's eyes.

7. *Artificial light* should be reduced to a minimum, and extinguished not later than 6 P.M. in the case of children, and 8 P.M. in that of adults. There is no more reprehensible practice, in my judgment, in the treatment of acute disease, than that of permitting the patient only to settle down for the night at 10 or 11 o'clock, since the evening and the early morning are the periods during which the patient chiefly rests.

8. The *excreta* should be attended to in bed throughout the entire illness, however favourable be its type.

9. No patient, however mild the illness, should be permitted to *get up* for any purpose until twenty-one days have elapsed. This course, in my experience, prevents complications more completely than any other plan in treatment; and where it is not enforced frequent returns to bed must be made in view of complications arising.

10. Some authorities advise, with the careful avoidance of a chill, that the surface of the body should be *washed* with soap and water every morning, with tepid sponging every night.

11. Others recommend a *daily bath* as soon as the fever ceases and the strength permits.

12. Many postpone these courses of ablutions, except for purposes of cleanliness, until the close of the third week, in the belief that their tendency is to increase the frequency of affections of the kidneys; and in substitution resort to oiling the body daily with *carbolic oil*. I concur with the advocates of this last course, which I highly recommend. But who dare assert in the treatment of scarlet fever "*post hoc ergo propter hoc*"? The oiling of the skin maintains its softness and suppleness throughout the illness. It moreover entangles the shed epidermis in the night-shirt and sheets, and prevents the particles being blown about the room as dust. Baths are reserved for the stage where the invalid is sufficiently recovered to leave the bed—the twenty-second day—and should be then given every night until desquamation has ceased.

13. Certain cases, however, occur of severe cerebral symptoms, active delirium, intense headache, and hyperpyrexia, where *cold sponging* or the *wet pack* is of vital value. It reduces fever, diminishes the frequency of the pulse, abates the cerebral symptoms, and induces sleep.

14. As much *cold water* to drink as the patient desires should invariably be allowed. It quenches thirst more rapidly and completely than any other drink. If water be not relished, lemon juice, in soda water with a little sugar, forms a refreshing draught. Where food is taken sparingly it may be advisable, however, to withhold these drinks, and substitute milk, or milk and soda water.

15. The patient may get up on the twenty-second day for a couple of hours; on the twenty-third day this course may be permitted twice, with a rest of two hours' duration between in the horizontal position. The length of time out of bed may be gradually extended for four days, when the patient may be allowed to go into another room for two days; and then, in suitable weather, and properly clad in flannel, out of doors.

(ii.) *Dietetic.*—The diet must necessarily be adapted in every case to the constitution of the individual, the age, the nature of the attack, its duration, and its complications. And the maxim must be observed, that it is the patient who has contracted the fever who requires the treatment, and not the fever which has seized the patient. The days when bleeding was freely resorted to in fevers, and especially in scarlet fever, when the strongest antiphlogistics were administered, when practical starvation was enforced, followed, at a later period, by saturation of the patient with alcohol as a matter of routine, are memories only of the past. All

that now remains of that period of history is the practical adoption of the axiom which Graves bequeathed as his epitaph—"He Fed Fevers."

In an ordinary case of scarlet fever some such dietary rule as the following is a good working method:—

1. For the first four days the nourishment should consist exclusively of milk—not exceeding two or three pints, with as much water as is desired—with the exception, perhaps, of some lemonade and soda water.

2. For the next four days an egg and all forms of farinaceous food may be added.

3. During the ensuing four days the diet may include some weak broth, fish, fruit, and vegetables.

4. After this period poultry, game, and meat may be gradually allowed, and the food administered as freely as is desired.

In young children and adolescents the amount of food that can be consumed with impunity, where it has been withheld during the primary course of the illness, is astonishing.

When feeding has begun at an earlier stage, such as I have seen prescribed in slight cases of scarlet fever which presented no palpable illness, and where an ample diet has been strenuously demanded in consequence of appetite, the course has usually proved, in my experience, the precursor of albuminuria and other troubles.

5. Where marked anorexia exists; or where, owing to the severity of faucial ulceration, or submaxillary swelling, deglutition, in consequence of pain, is well-nigh impracticable, the food swallowed should be of the most nourishing character, such as milk, eggs and milk, raw meat juice, and chicken jelly. Stimulants may also be necessary in such instances, and must be regulated according to the age of the patient, his state of debility, and the nature of the attack. I veto all commercial preparations of "wine and meat juice," so extensively employed, since they are invariably made with very inferior wine.

6. Where food is absolutely refused administration must be effected by the nose, and the necessary mode of operation in these cases is the insertion of the tube for half an inch in one nostril, with the closure of the other, and the fluid is allowed to descend into the stomach in gulps only.

(iii.) *Curative.*—1. *The Neutralisation of the Poison.*—Until the antitoxin of scarlet fever is discovered no drug which we possess can be said to be absolutely reliable. Various drugs for this purpose have been advocated from time to time. Personally I have found the biniodide of mercury efficacious, not only in arresting the fever, but in minimising the desquamation, and reducing the duration of the illness and the necessary isolation. But it would require more extended experience than mine, in a disease like scarlet fever, to affirm that a causal connection exists between this treatment and the result. Other physicians have also adopted the sulphocarbolates and the hypo-sulphites with apparent advantage.

2. *The promotion of elimination of the fever poison.*

(α) The primary requirement in the treatment of all fevers is the unloading of the alimentary canal at the start; for this course alone, by increasing the action of the excreting organs, will often at once convert an apparently serious illness, commencing with alarming symptoms, into one of a milder type.

This procedure must be effected in scarlet fever with caution, on account of the tendency to vomiting and diarrhœa at the onset, which sometimes form ominous symptoms in the anterior stage, and invariably so at later periods. Aperients, therefore, should generally be avoided during the earlier history of scarlet fever. This does not affirm that they should be absolutely dispensed with, but simply that they should be employed with judgment and caution. A simple enema is sometimes the least injurious remedy; but a saline aperient, a small dose of a mercurial, or of liquorice powder, may be necessary, and will be found to be safe.

(β) *Febrifuges.*—A mixture of a saline nature, such as acetate of ammonia, accompanied by nitre, or nitric ether, or chlorate of potash, where the throat is much involved, is desirable.

3. *The Reduction of Temperature, and of the Frequency of the Heart's Action.*—Where the temperature is unusually high, and the pulse frequency excessive, tepid or cold sponging, and the use of the wet pack, are sometimes of incalculable value.

4. *The Improvement of the Condition of the Blood.*—As marked anæmia sometimes attends, or follows scarlet fever, the use of iron and arsenic is indicated at a later stage.

5. *The relief of distressing symptoms.*

(α) Troublesome affections of the *nervous system* are the first to appear, and comprise headache, delirium, convulsions, restlessness, and insomnia. These are greatly relieved by tepid sponging or the wet pack. A small dose of Dover's powder, varying according to age, is useful for young patients; and of paraldehyde, phenazonum, sulphonal, or the bromides for older ones.

(β) Where *hyperpyrexia* occurs, the cold affusion or the wet pack, as I have already stated, possesses the greatest value in these desperate cases, which eventually, however, are too frequently fatal.

(γ) Symptoms affecting the *throat* are the most distressing of all to the patient, and demand immediate assistance for their relief. The greatest benefit is derived from *hot* drinks. All food should be administered in this form; and the facility and ease of swallowing them

are astonishing. Sucking ice is also agreeable. Gargling, inhaling, and spraying the throat with antiseptics, such as permanganate of potash, boracic acid, and sulphurous acid, afford material aid where the strength permits their employment. A local wet pack or hot fomentations to the throat also produce relief. In sloughy, ulcerated, foul throats, chlorine water (called euchlorine), locally applied, as well as swallowed, is of the greatest service.

(δ) Where the *submaxillary region* is enormously swelled, early incisions not only relieve instantly, but may also prevent suppuration.

(ε) *Adenitis.*—The same observation applies to inflammation of glands.

(ζ) *Otitis* commences with earache, which can be relieved by gentle syringing with hot water, followed by opium, atropine, or cocaine applied in the ear. Mustard, applied behind the ear, sometimes arrests the inflammation when employed early. When the pain is severe, and the temperature high, the application of leeches in front of and behind the ears speedily removes the pain and arrests further mischief. If, however, suppuration supervene, incision of the tympanum is called for; while, if perforation occur, irrigation with antiseptics such as boracic acid is essential, followed by insufflation of dry boracic acid or iodoform. If the mastoid become tender or reddens, an early incision through the periosteum, or even gouging, should be effected without hesitation.

(η) *Diarrhœa* may require treatment, either by starch and opium injections or by opium and bismuth given internally.

(θ) *Rheumatism* may demand treatment with salicylates, liniments, or blisters; and if suppuration of a joint supervene, an incision, with antiseptic precautions, should be made.

(ι) *Albuminuria.*—Where simple albuminuria arises in the course of scarlet fever a prolonged stay in bed is requisite, and a milk and farinaceous diet should be prescribed. Where, however, simple albuminuria exists from the onset no significance may possibly be indicated beyond a hyperæmia of the kidneys; even in these cases, nevertheless, the preceding course is advisable.

(κ) *Acute Nephritis.*—In this acute attack, accompanied by hæmaturia and scanty urine, the kidneys should be rested through action upon the skin and bowels, and by aiding the reduction of arterial tension.

(1) As regards the *skin*, hot air and vapour baths, hot wet pack, and hot drinks should be employed.

(2) As regards the *bowels*, bitartrate of potash, Epsom salts, and compound jalap powder should be used.

(3) *Arterial tension* may be efficiently relieved by nitro-glycerine or erythrol-tetranitrate, by leeches, wet-cupping, venesection; and where the urine is suppressed, an incision through the capsule of the kidney itself may save life. If convulsions occur, morphia or chloroform may be required. If pulmonary œdema arise, venesection, sufficient to relieve the right side of the heart, may be necessary, together with the administration of digitalis and nux vomica. When relief has been afforded to the kidneys their normal functions are resumed, the hæmaturia disappears, and the headache and vomiting cease. For this purpose iron, in conjunction with sulphate of magnesia, is very efficacious. If recovery take place a prolonged stay in bed, clothed in flannel, is essential, followed by residence in a warm, dry climate.

(λ) *Ataxic Symptoms.*—Where these symptoms arise, carbonate of ammonia, musk, and alcohol are imperative; transfusion, or hot saline injections, may prove of service.

(μ) *Eczema.*—Where eczema occurs at the orifices of the mouth, nose, and ears, hot boracic lotion alleviates rapidly, and may be followed by the application of oleate of zinc or boracic ointment.

(ν) *Ulcerative Stomatitis.*—In mild cases of this description alkalies and opium bestow relief; but in severer forms the local use of euchlorine should be adopted. And if the inflammation proceed to noma, fuming nitric acid, after an anæsthetic, is indispensable.

(iv.) *Convalescents.*—On the termination of the illness the patient, in mild cases, is perfectly well, and requires no further care. But the state of health after an attack of the severe type may demand the most assiduous treatment on account of the condition of the blood and the state of the kidneys, throat, and ears. A sojourn of many months in a warm, dry climate may be essential to complete recovery.

(v.) *The Limitation of the Disease.*—We have hitherto discussed those points only which relate to the treatment of the individual attacked. In consequence, however, of the infectious nature of the disease, and its frequently epidemic character, a few words are necessary with reference to the protection of those who are not already infected. These I shall offer in the form of suggestions only, without discussion of the detailed method of procedure.

1. *Notification.*—The value of *notification*, in addition to its use for statistical purposes, consists in securing the isolation of the sick person and the nurse.

2. *Disinfection.* — A. *Disinfection* DURING *Illness.*

(α) All the excreta, expectoration, urine, and excrement should be received into vessels containing perchloride of mercury, or one of the tar derivatives. The nasal secretion should be excreted into pieces of linen, which should be immediately burnt.

(β) The body, in all cases, should be washed sufficiently for purposes of cleanliness.

(γ) The body linen and the bed linen should be changed as often as may be requisite for cleanliness. It should be received into vessels containing a disinfectant as soon as removed from the patient, and before it leaves the room.

(δ) The nurse's linen and clothes should be subjected to similar treatment to that adopted for the patient's.

(ε) The room should be rubbed over daily with a damp cloth wrung out in a disinfectant.

B. *Disinfection* AFTER *Illness.*

(α) Disinfecting *baths* are necessary for many days before the patient is allowed full liberty.

(β) Fresh *clothes* should be worn before this liberty is granted. But where a disinfecting chamber is available that plan of disinfection may be safely adopted.

The patient should enter a bath-room for the purpose of disinfecting his body, and his clothes can meanwhile be passed through the steam disinfector, and come out on the other side into a fresh room where the patient can receive and assume them, taking his departure thence.

(γ) But I do not regard any disinfection to be sufficiently safe to enable the patient to be discharged when, up to the time of his discharge, he has been in communication with *recent cases of scarlet fever.* In my opinion, it is under such circumstances, unless gross carelessness has occurred in the disinfecting arrangements, and a want of scrupulous conscientiousness in their execution, that return cases of scarlet fever arise, besides those where discharges from the ears, nose, mouth, and vagina are still proceeding.

(δ) The whole of the *bedding* of patient and nurse should also be passed through the steam disinfector.

(ε) The infected room requires efficient disinfection. The paper should be stripped, the ceiling whitewashed, and the paint, floor, and furniture washed with carbolic solution. Sulphur should also be burnt, as it permeates into every crack and crevice, or formalin sprayed. After this process has been completed, and no articles of clothing have escaped the disinfecting chamber, the room should be exposed, day and night, to a cross draught of fresh air for several days.

Scarpa's Triangle. *See* ARTERIES, LIGATURE OF (*Superficial Femoral*); GROIN (*Anatomy of*).

Scars. *See* CICATRICES.

Scelalgia.—Pain in the leg (Gr. σκέλος, the leg, ἄλγος, pain).

Scelo-.—In compound words *scelo-* (Gr. σκέλος, the leg) means relating to the leg; *e.g. scelocambosis* (genu varum), *scelodesmus* (a bandage for the leg), and *scelodidymus* (ischiopagous monster).

Scelotyrbe.—A nervous disorder characterised by weakness and by irregular movements of the legs (Gr. σκέλος, the leg, and τύρβη, disorder), as in chorea and paralysis agitans.

Schäfer's Method. — A method (postural and manual) for the restoration of the apparently drowned. *See* ASPHYXIA (*Resuscitation, Methods*).

Schatz's Method.—In obstetrics the term Schatz method is given to a form of external manipulation or version by whose means a face (or brow) presentation is changed into a vertex; the fœtal head must not yet be engaged, and, as a rule, the membranes must not be ruptured if this manœuvre is to be successful. *See* LABOUR, MANAGEMENT OF (*Face Presentations*).

Schede's Method. — A method of dealing with caries and other diseases of bone, in which the diseased tissue is scraped away, the resulting cavity allowed to fill with blood-clot, and the latter kept aseptic till healing occur.

Scheele's Green. — Cupric arsenite ($CuHAsO_3$); Brunswick green or Schweinfurth green. *See* TOXICOLOGY (*Arsenic*).

Scheele's Method.—A method of inducing premature labour by tapping the membranes and allowing the liquor amnii to escape; rarely applicable.

Scheiner's Experiment.—An experiment for demonstrating that near and far objects cannot be distinctly seen at the same time. *See* PHYSIOLOGY, NEURO-MUSCULAR MECHANISM (*Vision, Positive Accommodation*).

Schelnesa Wodsk. *See* BALNEOLOGY (*Russia*).

Schematic.—Of the nature of a *schema* or outline of any subject; diagrammatic; according to a formula.

Schenck's Method.—A method by which it was expected that the sex of the child before birth might be determined; it consisted in altering the diet of the mother so as to prevent the slightest trace of sugar in the urine, if a male infant were desired.

Schering's Lamp.—A lamp in which formaldehyde is heated in the presence of water vapour in order to produce formic aldehyde gas for purposes of gaseous disinfection.

Scherlievo. *See* VENEREAL DISEASE (*Scherlievo* or *Mal de Fiumee*).

Scheurlein's Bacillus.—A micro-organism once believed to be connected with the origin of cancer.

Schiff's Test.—This name is given to four different tests, one of which is for the detection of carbohydrates in urine, another for the detection of cholesterine, another for urea, and another for uric acid.

Schindylesis.—A variety of synarthrodial joint in which the edge of one bone (*e.g.* the rostrum of the sphenoid) articulates with the cleft of another (*e.g.* the vomer).

Schinznach. *See* Balneology (*Switzerland, Sulphur Waters*).

Schisto-.—In compound words *schisto-* or *schizo-* (Gr. σχίζω, I split) means cleft or divided; *e.g. schistorrhachis* (spina bifida), *schizogenesis* (reproduction by fission), etc.

Schistocephalus. — A teratological type characterised by fissure of the cranium; *e.g.* there may be a median fissure of the face splitting the head in two (*schistocephalus bifidus* of Gurlt), or there may be hare-lip (*schistocephalus fissilabrus*).

Schistocœlia.—A teratological type in which there is a split condition of the abdomen with extroversion of the viscera.

Schistocormus.—A teratological type in which there is a defect in the wall of the body cavities (abdominal or thoracic); *e.g. schistocormus exomphalus* (congenital umbilical hernia), *schistocormus fissiventralis* (gastroschisis), *schistocormus fissisternalis* (ectopia cordis); and *schistocormus fissicollis* (fissure of the neck).

Schistocyte.—A blood corpuscle in a process of segmentation, or a poikilocyte; *schistocytosis* is that condition of necrobiosis of the blood in which there is fragmentation of the cells.

Schistoglossia.—Congenital fissure of the tongue.

Schistoprosopus. — A teratological condition consisting in the presence of a facial cleft.

Schistosomum.—A variety of parasite belonging to the trematodes; *e.g.* the *schistosomum hæmatobium* or the *schistosomum bovis s. crassum*. *See* Parasites (*Trematodes*).

Schistosomus.—A teratological type in which there is a fissure of the body cavity, affecting usually both the thorax and the abdomen.

Schistotrachelus. — Congenital fissure of the neck.

Schizoblepharia.—A congenital cleft of the eyelid, or coloboma palpebrarum.

Schizomycetes.—Fungi or bacteria which multiply by fission, the cleft-fungi. *See* Micro-Organisms (*Bacteria*).

Schlafsucht. — The German medical term for abnormal somnolency.

Schlangenbad. *See* Balneology (*Germany*); Mineral Waters (*Thermal*).

Schlange's Sign.—The presence, in cases of intestinal obstruction, of dilatation of the bowel above the site of obstruction, and the absence of peristaltic movements below it.

Schleich's Mixture. *See* Anæsthesia (*Mixtures of Ether and Chloroform*); Anæsthesia (*Local Anœsthesia, Infiltration*).

Schlemm's Canal. — The circular canal found at the corneo-scleral junction of the eye, by which the aqueous humour communicates with the scleral veins; sinus venosus scleræ.

Schlösing's Method.—A method of estimating the amount of ammonia in urine by adding lime. *See* Urine, Pathological Changes in (*Inorganic Constituents, Ammonium*).

Schmidt's Method. — A clinical method of demonstrating functional intestinal disturbances by giving a fixed and special diet, and testing whether the resulting fæces undergo fermentation when mixed with water and placed in a fermentation-tube at 37° C.; in normal circumstances no fermentation should take place, but when the digestion of starch is faulty it does.

Schmidt's Test.—The static test of live birth founded upon the absolute weight of the lungs, it being known that lungs which have breathed weigh more than those which have not, but it is unreliable; Foderé's Test.

Schneiderian Membrane.—The mucous membrane of the nose, so named after Conrad Victor Schneider, anatomist (b. 1614, d. 1680).

Schoenlein's (or Schönlein's) Disease.—Purpura, or peliosis rheumatica. *See* Purpura (*Arthritic*).

Schöller's Method.—A method of inducing premature labour by plugging the vagina.

Schools and School Children, Medical Examination of.

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See also CHEST, DEFORMITIES OF; CHILDREN, DEVELOPMENT OF; CHILDREN, CLINICAL EXAMINATION OF; CHOREA (*Etiology, Imitation at School*); COLOUR VISION; DEAFMUTISM; DEFORMITIES; DIPHTHERIA (*Etiology, School Influence*); DISINFECTION (*Quarantine*); EPIDEMIOLOGY; HEARING; HEART, CONGENITAL MALFORMATIONS; MENTAL DEFICIENCY; OCULAR MUSCLES, AFFECTIONS OF; etc.

1. INTRODUCTORY. — Medical inspection of school children is not a new proposal; it has been practised for many years in the great public schools of England, in a large number of private schools, in all the industrial and reformatory schools, and in the Poor Law schools. In all these institutions, however, the intention of medical inspection has been to see that the health of the pupils is maintained. This involves treatment as well as inspection. Neither treatment nor inspection has hitherto had any special relation to the school child as such; the purpose of it has rather been to satisfy parents and public bodies that the children are medically protected. Recently, the movement for medical inspection of school children has taken a wider sweep. In Britain, the immediate cause of this greater movement was the South African War. For years it had been found that too large a proportion of recruits had to be rejected for ailments of many kinds; the necessity for increased superintendence of physical growth became manifest, and the Royal Commission on Physical Training (Scotland) was appointed in 1903. The evidence laid before this Commission made it clear that many of the defects found at the recruiting stations had their origin in early life; that physical training in schools could not be efficiently developed except under medical supervision; that, even for the purposes of general education, medical inspection of the school children was called for. The Commission, having very few scientific facts to guide them, ordered an examination of twelve hundred representative Scottish school children. The facts emerging in this investigation, limited though it was, were more than sufficient to justify the Commission in recommending medical inspection. The Commission's Report made a strong impression everywhere. In the following year, 1904, there was appointed an Interdepartmental Committee on Physical Deterioration. This Committee followed the lead of the Scotch Commission, but widened the scope of the inquiry. In their report, they recommended medical inspection of school children as one among some fifty suggestions for the prevention of physical deterioration. Meanwhile, facts were accumulated from Glasgow, Dundee, and some other centres. It is estimated that over ten thousand children from Scottish schools have been carefully examined.

In many towns of England, Medical Officers, under the powers of the Education Act of 1902, were appointed to examine the school children. A second Inter-departmental Committee prepared an elaborate report on the extent to which school authorities had exercised their powers under the Act. It was found that a large number of authorities had appointed Medical Officers of Health and other medical men to superintend the health of the schools, and, in certain cases, to make detailed examination of the children. In London, many years ago, while as yet education was under the direction of the London School Board, a Medical Officer of Schools had been appointed. When the Board was superseded by the London County Council, the Medical Officer (Education) was transferred, and remains as a leading officer of the County Council. He has a large staff of male and female medical assistants, some giving their whole time, others part of their time, to the work. There is also a staff of special nurses and visitors. In Bradford, for many years, medical inspection of schools had attained to a high level of elaboration. Both in Bradford and in London, Dr. James Kerr was a pioneer. His London reports are always rich in new materials for the study of School Hygiene. Further details of the position of medical inspection in England before 1907 may be obtained from the Report by the Inter-departmental Committee on Medical Inspection, etc.

In 1907, the Education (Administrative Provisions) Act was passed. By section 13 of that Act the Local Educational Authorities received the following powers:—(*a*) "Power to provide (for children attending Public Elementary Schools) vacation schools, vacation classes, play centres, etc.; (*b*) the duty to provide for the medical inspection of children immediately before, or at the time of, or as soon as possible after, their admission to a Public Elementary School, and on such other occasions as the Board of Education direct; and the power to make such arrangements as may be sanctioned by the Board of Education for attending to the health and physical condition of the children educated in Public Elementary Schools: provided, that in any exercise of powers under this section, the Local Educational Authorities may encourage or assist the establishing or continuance of voluntary agencies, and associate with itself representatives of voluntary associations for the purpose." This section came into operation on the 1st day of January 1908. Meanwhile, the English Board of Education had already constituted a new Medical Department. Dr. George Newman was appointed Medical Officer to the Board, with a staff of assistants. On the 22nd of November 1907 the Board issued an elaborate "Memorandum on Medical Inspection of Children in Public Elementary Schools, under section 13 of the Education Administrative Act of 1907" (Circular 576). This memor-

andum, which extends to twelve pages, is an admirable discussion of the general problem as it affects England. It shows the relation of the school to the home; the necessity for maintaining this relationship; the importance of the many public health problems issuing from the schools; the need for co-operation between teachers and doctors; the organisation of inspection; the character and degree of medical inspection, and a large number of other details. The general scheme thus outlined was, later, made more definite by the issue of a schedule, which, on the whole, fulfils the original promise of the Circular, but does not give the expected prominence to the investigation of the home conditions. The Circular had been discussed by the British Medical Association, whose Committee also produced an elaborate schedule. The medical profession, in every branch, both general and special, has taken up the movement warmly, and already (1908) the organisation of it has proceeded with lightning-like rapidity. (For schedule, see below.)

In Scotland, the statutory organisation of the movement has proceeded less rapidly, but meanwhile much actual work has been done. The School Board of Edinburgh has appointed a whole-time Medical Officer of Schools (*see* regulations below). The Burgh of Kirkcaldy, in concert with the School Board, has made the Medical Officer of Health also Medical Inspector of Schools. The School Board of Govan have appointed ten private practitioners as part-time Medical Officers of Schools. The Medical Officer of the Dunfermline Carnegie Trust also acts as Medical Inspector of School Children, and has already issued two annual reports. The School Boards of Inverness and of one or two other localities have appointed Medical Officers. In the counties, the County Medical Officers of Health have, within the last two or three years, given special attention to the medical and sanitary supervision of schools, and several of them have issued elaborate statements in their annual reports.

The School Board of Glasgow, in 1906, issued a report of the examination of the eyes of fifty thousand school children, and in 1907 the Scotch Education Department tabulated the results of the examination of the heights, weights, and housing of seventy-two thousand Glasgow school children (*see* below). Meanwhile, at the Training Centres for teachers—Edinburgh, Glasgow, Dundee (St Andrews), and Aberdeen—Medical Lecturers have been appointed by the Provincial Committees to give to the "students in training" instruction in School and Personal Hygiene, with special reference to the ultimate establishing of a complete system of medical inspection. The Training Centres are now, with the exception of the Episcopal Training College, Edinburgh, and the Roman Catholic Training College, Glasgow, under the sole management of the Provincial Committees, and the four Medical Lecturers devote their whole time to the work, receiving such medical and lay assistance as may be rendered necessary by the large classes. The two Denominational Colleges have also Lecturers, but they give only part of their time to the work. In all, there are some nine medical men or women devoting, with two exceptions, practically their whole time to the work of teaching Personal and School Hygiene. When, therefore, medical inspection comes to be organised in Scotland, the younger generation of teachers will be fully prepared for it. Further, in the end of 1907, the Scotch Education Department issued directions for the Cleansing and Disinfecting of Schools. Under the conjoint authority of the Scotch Education Department and the Local Government Board for Scotland, these directions have been circulated among all the School Boards and Public Health Local Authorities and Officials of Scotland. By these various methods the way has been prepared for the medical inspection of school children in Scotland. In the Bill now before Parliament a clause has been inserted to do for Scotland what the Act of 1907 did for England, namely, to establish a full system of Medical Examination and Supervision of School Children.

So far Great Britain. But in Germany, Switzerland, France, Austria, America, Japan, and some other countries, medical inspection has been established for several years. For example, in Wiesbaden the school children have been medically inspected on admission and periodically thereafter since the year 1898. In Nuremberg, a similar system has been in force for about the same period. In Berlin, Charlottenberg, Vienna, and many other towns the same is true. In a considerable number of towns, in Germany and elsewhere, elaborate investigations have been made into the eyes of school children. In fact, it may now be said that medical inspection is practically established, in greater or less degree, in all civilised countries.

Medical inspection and the reports following upon it formed a leading part of the First International Congress on School Hygiene, which was held in Nuremberg from the 4th to the 9th of April 1904. At that Congress there were some fifteen hundred delegates of all nations. The report of the Congress forms four volumes of over five hundred pages each. These volumes are repertories of facts and investigations into the whole hygiene of school life.

The Second International Congress was held in London in August 1907. Medical Inspection of School Children was specially discussed, and no doubt this discussion had much to do in determining the lines of the Circular issued

later by the Board of Education. As at Nuremberg, so at London, great masses of material bearing on medical inspection were produced, and will be made available in the Report of the Congress. The third Congress meets in Paris in 1910.

These facts show that the medical inspection of school children is no isolated phenomenon. It is part of a world movement towards personal hygiene. Hitherto, the energies of the Public Health movement have been mainly exercised in securing a good environment. The new public health departure of the Twentieth Century is the effort to increase the capacity and fitness of the organism. The fundamental proposition of this movement is that the early nurture of the child is a primary factor in the development of the adult. Incidentally, the school child is selected for detailed examination because the schools are public institutions, great masses of children are easily found there, and it is on every hand recognised that education, either physical or mental, cannot produce effective results where the children suffer from disease or physical defects. Hitherto it has been assumed that the children are normal; this assumption has been displaced by masses of facts to the contrary. And, practically within three years, the public mind of Great Britain has been won over to the view that medical inspection of school children at the public cost is a necessity of our present social condition.

2. The Scope and Nature of Medical Inspection.—The work that falls to a medical inspector of schools will best be understood from a concrete case. The following is a summary of the duties required of school doctors in the town of Wiesbaden.

The school doctor exercises a general supervision over the pupils, the school-rooms, sanitary appliances, bathing installations, and all other conditions affecting the health of the children. He must make a systematic examination of all pupils on admission, recording the results in a schedule. He must mark off those that require special medical supervision during their school course, all those to be exempted from gymnastics or any special class, all those that are not equal to the full course of instruction, all those requiring special positions on account of defective eyesight or defective hearing. The schedule containing these details accompanies the child all through his school course; it is handed from teacher to teacher as the child passes from class to class, and if the child is transferred to another school, he takes the schedule among his papers. The doctor, under the heading "General Constitution," must state for each child whether the constitution is good, medium, or bad. The term "good" is to be used only where the health is perfect, and "bad" only in pronounced cases of illness or chronic ailments. The pupils are weighed and measured by the teachers, and the results are also recorded on the schedule every half-year. The height is taken to the half centimetre and the weight to the quarter of a kilogram. The chest measurement is made by the doctor, but only in children suspected of lung diseases.

Every fortnight, and oftener if there is infectious disease, the school doctor visits the school. Usually a room is placed at his disposal in the school. He consults with the head master; he visits the class where any case has been set aside for his inspection; he spends part of the time observing the conditions of the class; he examines systematically any cases brought before him, and he records his observations and instructions. Each class must, if possible, be visited twice during the half-year. This examination of the class is very brief. Usually the teachers prepare a list of the cases. The doctor, at those visits, makes a rapid inspection of the ventilation, the heating, the deportment of the children, etc. The particular class teacher must be present at the medical examination. Medical treatment of the children is no part of the school doctor's duties. Children requiring treatment are, through the headmaster, recommended to the family physician or to the Poor Law doctor or any available dispensary or clinic. With the older children, such recommendations are given by word of mouth, but in many cases a written recommendation is sent to the parent. Where no result follows the verbal recommendation, a special report form is filled up. But this is done only where the illnesses are serious. The head master is responsible for sending this report to the parent.

Where no other sufficient medical certificate is forthcoming, the school doctor must, at the instance of the head master, visit the homes in order to ascertain whether absence from school is justified.

Twice a year—once in summer and once in winter—the school doctor must examine the school premises and installations. His observations must be recorded in a register kept for the purpose. If any defects found are not remedied, he reports the matter to the School Hygiene Committee. In special cases, he may give notice to the school inspector and to the Medical Officer of Health of the district. In winter, the school doctor gives to the teacher short expositions on the most important questions of school hygiene.

Each year he prepares a report to the educational authority (the municipality). This report includes (1) a tabular, numerical statement of the results of the admission examinations; (2) the number of medical visits to the classes; (3) the number and kind of the more important cases of illness discovered at those visits; (4)

any special medical instructions, such as the remitting of instruction, gymnastics, etc.; (5) the number of written reports sent to the parents; the number of school children remaining under medical control; a summary of the instructions given on the hygiene of the school.

3. Practice of Medical Inspection.—The extent of the examination to be undertaken at school depends on the purpose of medical inspection. This purpose is to prevent unfit children from entering on a course of instruction; to eliminate from the school such unfit children as are found there; to discover all such defects as interfere with the education of the child; to indicate what measures must be taken to have all defects remedied or ameliorated. Incidentally, the examination may serve strictly scientific ends; but the primary end is not scientific statistics, but the practice of education. Accordingly, the devising of a practical schedule becomes a matter of serious consequence. The schedule should include only what is practicable within school conditions and necessary for the full education of the child. In the schedule devised by Professor Matthew Hay for the Physical Training Commission (Scotland) there were included a large number of items that had only a scientific interest. In the schedule devised by the present writer for routine medical inspection all the main clinical items of Professor Hay's schedule were retained; some hygienic items were added, but the items of merely scientific interest were dropped. (See *The Medical Inspection of School Children*, Appendix.)

It is not advisable to overload this article with a variety of schedules; but the relation of the home to the school is of such primary importance that I transcribe the first section of the schedule that seems to me best.

I. Address, Occupation of Parents, etc.

Session began.....
Date of Medical Inspection,.....
Name of pupil,.....
Date of birth,.....day,.....month,.....year.
Place of birth,.....
Age—years and months,.....
Residence or address,.....
Number of rooms in house,.....
Number of family and lodgers in house,....
Father's occupation,.....
Mother's occupation (if any),.....
Does pupil work before school hours?.....
Does pupil work after school hours?.....
If so, at what occupation?.....

All these items have a direct bearing on the capacity of the child for school work. Now that feeding of children has become a possible duty of the school authority, the above items are all the more important.

In other respects practically all the same items, with detailed directions, have been included in the schedule issued by the English Board of Education. The home conditions may be recorded under "general observations," etc. This schedule is of such importance, both historically and practically, that we reprint it here. It has been issued in a card form, with a full circular of directions.

Circular to Local Education Authorities.
Schedule of Medical Inspection.

Circular 582.

BOARD OF EDUCATION,
Whitehall, London, S.W.,
23*rd January* 1908.

Education (Administrative Provisions) Act 1907, Section 13.

1. The accompanying Schedule has been drawn up in response to requests which the Board of Education have received for further and more definite guidance as regards the details of the work of medical inspection than was given in the Memorandum (Circular 576) which was issued by the Board on 22nd November 1907. The Board have, indeed, been pressed by many Local Education Authorities to issue a complete set of Forms for use in carrying out the work directly or incidentally involved in the performance of these new duties. Any Forms which experience of the working of the Act may show to be necessary or desirable will be issued in due course, but for the present the Board think it expedient to leave considerable latitude, subject to the considerations hereinafter set out, in regard to the particular Forms or Schedules to be used in different cases or circumstances.

2. The chief difficulties to be considered are administrative rather than educational or scientific. There is comparatively little dispute as to the end in view, or as to the means which, from the technical standpoint of medical science and practice, should be adopted for its complete attainment.

But the existing resources of Local Education Authorities are (for practical purposes, at all events) not unlimited, the feelings and prejudices of parents have to be considered, and a new element has to be introduced into school life and organisation with the least possible disturbance and inconvenience. Moreover, in this case two departments of local public administration are brought for the first time into organic connection—those of public health and of public education.

3. The Board are fully aware of these difficulties, and in preparing their Memorandum and Regulations it was necessary for them to consider what system would best reconcile the theoretical and practical considerations, and overcome the divergence between the ultimate end and the end immediately attainable, or between the methods which are scientifically desirable and those which can be applied in

existing circumstances at the initiation of the work under the Act.

4. In the accompanying Schedule the Board indicate the particulars, attention to which they regard as constituting the *minimum* of efficient medical inspection, and they consider that at least these particulars should be included in any other Schedule which the Local Education Authority may authorise for use in their Schools. It deliberately excludes many points of anthropometric or statistical interest which are worthy of attention, and which it is hoped may receive attention in suitable districts. Nor does it profess to lay down the lines of a clinical study or of a scientifically complete medical examination. It is intended to indicate the methods which, in the Board's opinion, should be followed and the particulars which should be attended to for the purpose of determining the fitness of the individual child for school life, to guide the Authority in adapting education to the peculiarities or abnormalities of the child, and to prepare the way for measures for the amelioration of defects in the child or its environment.

A more elaborate and complete form could readily be devised, but the Board's knowledge of the circumstances in which the work is to be done leads them to believe that greater elaboration would in the majority of cases defeat its own end.

5. If this Schedule is properly used, few cases of serious physical weakness or defect will escape detection. Where the ordinary inspection shows the need of further and more searching medical examination a supplementary blank form should be used in which particular defects or diseases should be fully recorded. It may facilitate inspection if the Schedule is printed on cards[1] (8″ by 5″ or 10″ by 6″). The notes are included in the attached form for the convenience of the School Medical Officer, and should not be reprinted on the cards. Of course it is not necessary that negative findings on all the points mentioned in the notes should be recorded.

It will be noticed that a space is reserved in the Schedule for "General Observations"; this may conveniently be used to record a general summary of the condition of the child, and any information which may be available as to the home environment, or other conditions affecting its health.

It is considered that the inspection of each child should not occupy on the average more than a few minutes, and that the child need only, as a rule, have its clothes loosened or be partially undressed. Time may be saved in the actual inspection by the Medical Officer if the entries in some of the spaces are filled in by the school authorities before his visit. The four columns in the Schedule are designed for the four inspections required during school life.

With regard to items 17 to 24 of the Schedule, while it is necessary that all indications of diseased or unsound conditions should be thoroughly investigated, needless medical examination of healthy children should, for obvious reasons, be avoided.

6. Where children are found to belong to that class of "defectives" for whose education special provision is or ought to be made under the Statutes relating to such children, such cases should be made the subject of a special report to the Local Education Authority.

7. *All entries of the results of inspection in each individual case must be regarded as confidential.*

SCHEDULE OF MEDICAL INSPECTION

(Accompanying Circular 582)

Notes for Inspecting Officer

Reference Number of Note.

1. Date of birth to be stated exactly, date of month and year.
2. "Other illnesses" should include any other serious disorder which must be taken into account as affecting, directly or indirectly, the health of the child in after-life, *e.g.*, rheumatism, tuberculosis, congenital syphilis, small-pox, enteric fever, meningitis, fits, mumps, etc. The effects of these, if still traceable, should be recorded.
3. State of any cases of, or death from, phthisis, etc., in family.
4. Note backwardness.
5. Age to be stated in years and months, thus, $5_{\frac{4}{12}}$.
6. Insufficiency, need of repair, and uncleanliness should be recorded (good, average, bad).
7. Without boots, standing erect with feet together, and the weight thrown on heels and not on toes or outside of feet.
8. Without boots, otherwise ordinary indoor clothes.
   Height and weight may be recorded in English measures if preferred. In annual report, however, the final averages should be recorded in both English and metric measures.
9. General nutrition as distinct from muscular development or physique as such. State whether good, normal, below normal, or bad. Under-nourishment is the point to determine. Appearance of skin and hair, expression, and redness or pallor of mucous membrane are among the indications.

[1] Specimen cards are enclosed, but cards will not be supplied with the copies of this Circular which are placed on sale.

Reference Number of Note.

10. Cleanliness may be stated generally as clean, somewhat dirty, dirty. It must be judged for head and body separately. The skin of the body should be examined for cleanliness, vermin, etc.; and the hair for scurf, nits, vermin, or sores. At the same time ringworm and other skin diseases should be looked for.
11. General condition and cleanliness of temporary and permanent teeth, and amount of decay. Exceptional features, such as Hutchinsonian teeth, should be noted. Oral sepsis.
12. The presence or absence of obstruction in the naso-pharynx is the chief point to note. Observation should include mouth-breathing; inflammation, enlargement, or suppuration of tonsils; probable or obvious presence of adenoids, polypi; specific or other nasal discharge, catarrh, malformation (palate), etc.
13. Including blepharitis, conjunctivitis, diseases of cornea and lens, muscular defects (squints, nystagmus, twitchings), etc.
14. To be tested by Snellen's Test Types at 20 feet distance (=6 metres). Result to be recorded in the usual way, *e.g.*, normal V. $=\frac{6}{6}$. Examination of each eye (R. and L.) should, as a rule, be undertaken separately. If the V. be worse than $\frac{6}{9}$, or if there be signs of eye strain or headache, fuller examination should be made subsequently. *Omit vision testing of children under six years of age.*
15. Including suppuration, obstruction, etc.
16. If hearing be abnormal or such as interferes with class work, subsequent examination of each ear should be undertaken separately. *Apply tests only in general way in case of children under six years of age.*

Reference Number of Note.

17. Including defects of articulation, lisping, stammering, etc.
18. Including attention, response, signs of overstrain, etc.
    The general intelligence may be recorded under the following heads:—(*a*) Bright, fair, dull, backward; (*b*) mentally defective; (*c*) imbecile. *Omit testing mental capacity of children under six years of age.*
19. Under the following headings should be inserted particulars of diseased conditions actually present or signs of incipient disease. The extent of this part of the inspection will largely depend upon the findings under previous headings.
20. Include heart sounds, position of apex beat, anæmia, etc., in the case of anything abnormal or requiring modification of school conditions or exercises.
21. Including physical and clinical signs and symptoms.
22. Including chorea, epilepsy, paralysis and nervous strains and disorders.
23. Glandular, osseous, pulmonary, or other forms.
24. State particular form, especially in younger children.
25. Including defects and deformities of head, trunk, limbs. Spinal curvature, bone disease, deformed chest, shortened limbs, etc.
26. Including any present infectious, parasitical or contagious disease, or any sequelæ existing. At each inspection the occurrence of any such diseases since last inspection should be noted.
27. Any weakness, defect or disease not included above (*e.g.* ruptures) specially unfitting child for ordinary school life or physical drill, or requiring either exemption from special branches of instruction, or particular supervision.

Schedule of Medical Inspection.

I.—Name_____ Date of Birth[1] _____

Address_____ School_____

II.—Personal History:

(*a*) Previous Illnesses of Child (before admission).

Measles.	Whooping Cough.	Chickenpox.	Scarlet Fever.	Diphtheria.	Other Illnesses.[2]

(*b*) Family Medical History (if exceptional).[3]

Schedule of Medical Inspection—*continued*

	I.	II.	III.	IV.		I.	II.	III.	IV.
1. Date of Inspection .					13. Ear disease [15] . .				
2. Standard and Regularity of Attendance [4] .					14. Hearing [16] . . .				
3. Age of Child [5] . .					15. Speech [17] . . .				
4. Clothing and footgear [6]					16. Mental condition [18] .				
					[V.—*Disease or Deformity.*] [19]				
[III.—*General Conditions.*]					17. Heart and circulation [20]				
5. Height [7] . . .					18. Lungs [21] . . .				
6. Weight [8] . . .					19. Nervous system [22] .				
7. Nutrition [9] . .					20. Tuberculosis [23] . .				
8. Cleanliness and condition of skin. [10]					21. Rickets [24] . . .				
Head . . .					22. Deformities, Spinal Disease, etc. [25] .				
Body . . .					23. Infectious or contagious disease [26] . .				
[IV.—*Special Conditions.*]					24. Other disease or defect [27] . . .				
9. Teeth [11] . . .									
10. Nose and throat [12] .									
Tonsils . . .									
Adenoids . .									
Submax. and cervical glands . .									
11. External eye disease [13]									
12. Vision [14] . . .									
R.					Medical Officer's initials.				
L.									

General Observations.

Directions to Parent or Teacher.

4. Results of Medical Inspection.—It is as yet premature to classify British results, because, up till now, the results have been mainly sectional and experimental; but in the reports and books given below much concrete information will be found. On the Continent, notably in Berlin, Charlottenburg, Wiesbaden, Nuremberg, Zürich, Breslau, and several other places, much material has been accumulated as the result of medical inspection. Much of this is available in annual reports. In this article it has been thought best to treat fully the administrative aspects of medical inspection.

5. Duties of the Medical Officer of Schools, or School Doctor.—Doubtless, the duties of medical officers of schools will vary considerably according to the locality, type of school, industry, population, etc. Further, the relation between the medical officers of health and the medical officers of schools will vary according as the Local Authorities for Public Health are, as in England, also the Local Authorities for Education. But, in general, the duties will be much the same. The following regulations, prepared by the Edinburgh School Board for the Medical Officer of Schools, may be taken as a general type, capable of adaptation to special circumstances. They may be extended according to circumstances; but it is not probable that, in any large School Board area, they can be diminished. They show that the work of a medical officer of schools has already become so important and exacting that we may now say that a new Medical Service has been created. What developments this service may undergo, no one can foretell; but that the developments will be great is beyond doubt. A new type of "clinical medicine" has thus arisen on the borderland between gross disease and perfect health. This new specialism is determined by the needs of educational practice, which can no longer proceed on the assumption that every child is normal and every mind equally fitted for instruction. But the need of thus at once adapting education to the child and the child to education elevates on to a higher plane all the minor ailments and defects. The result will be an enormous expansion of the preventive functions of the medical profession. No doubt, also, the question of hospital and private treat-

ment will receive an immense impetus. Already one result of medical inspection in London, as in other parts of England, has been to stimulate the discussion of how to discover diseases and how to arrange for their treatment. The same problem has already emerged in Scotland. It may be expected that, as time advances, the treatment both of minor and major ailments will steadily increase and the functions of the medical profession will grow in importance.

EDINBURGH SCHOOL BOARD

Regulations for the Medical Officer of Schools

1. He shall advise the Board as to new sites, plans of new Schools, and also, when required, as to School apparatus; he shall exercise a general supervision over the ventilation, heating, lighting, and cleanliness of the Schools; he shall periodically inspect all School lavatories and other sanitary installations, and he shall report immediately to the Headmaster, and, if necessary, to the Superintendent of Works, any insanitary conditions discovered.

2. On receiving intimation of an outbreak of infectious disease among the pupils attending any School, he shall at once inquire into the outbreak; he shall take such action as may be immediately necessary; and he shall, as soon as practicable, report the result of this inquiry to the Board, and to the Medical Officer of Health for the city, and shall co-operate with him in any measures he may propose for the prevention of infection.

3. He shall advise the Board as to the necessity for periodic disinfection and cleansing of the Schools, with a view to the prevention of disease.

4. He shall make such examination as the Board may require as to the mental and physical condition of children selected for Special Schools or Classes, and shall grant any necessary certificates.

5. He shall medically superintend all Special Schools and Classes; he shall keep the Board informed of the mental and physical progress of the children, and he shall indicate any measures that may be advisable for the preservation or promotion of their health.

6. On receiving intimation from the Chief Attendance Officer that a child is absent from School on account of alleged illness, he shall, where a medical certificate is not produced, inquire into the case and report to the Board.

7. He shall advise the Board as to the children remitted to any Day Industrial School and shall make such medical examinations and reports as may be required.

8. To the extent and in the form prescribed from time to time by the Board, he shall medically examine the pupils attending the Schools and shall preserve and maintain on approved schedules a record of the examination of each child.

9. He shall organise and superintend such systematic measurements and observations as the Board shall institute or approve,—for example, measurements of height and weight, improvement or deterioration of physique, and the like.

10. He shall from time to time inspect the physical exercises given in the Schools, and shall report to the Board any practices that he considers injurious to individual pupils.

11. If any child is specially reported to him by the Head Teacher as suffering from any ailment or defect or injury, he shall as soon as possible examine the child and give such directions as may be necessary.

12. When required, he shall medically examine candidates appointed to positions under the Board, Junior Students and Intending Junior Students, and report in cases of employees absent owing to illness.

13. He shall, after such examination as he may find necessary, certify the fitness of teachers or pupils to undergo special courses of Physical Training.

14. He shall, by lecture, demonstration, or otherwise, instruct the teachers in the methods of recognising the common ailments and defects of School children; in the practice of first aid for School accidents; in the general hygiene of the School and class-room, and in the physiological principles that underlie physical training.

15. He shall keep such records and books as the Board may prescribe or approve; he shall submit an Annual Report on the work done, and he shall make such special reports as the Board may require.

16. He shall perform any other medical duties that may be, from time to time, required by the Board; but medical or surgical treatment shall be no part of the Medical Officer's duty.

Adopted by the Board on 17th December 1906.

Literature.—1. The Medical Inspection of School Children. Text-book for Medical Officers of Schools, Medical Officers of Health, School Managers and Teachers. By W. Leslie Mackenzie, M.A., M.D., assisted by Edwin Matthew, M.A., M.B., C.M., F.R.C.P.E. (William Hodge & Co., Edinburgh and Glasgow.)

2. The Health of the School Child. By W. Leslie Mackenzie. (Contains some account of Medical Inspection in Germany.)

3. Report of Royal Commission on Physical Training (Scotland), 1903. (Blue Book.) (Contains Reports on Edinburgh and Aberdeen Schools.)

4. Report of Inter-departmental Committee on Physical Deterioration, 1904. (Blue Book.)

5. Report of the Inter-departmental Committee on Medical Inspection and Feeding of

School Children attending Public Elementary Schools, 1905. (Blue Book.)

6. Report by Dr. W. Leslie Mackenzie and Captain Alan Foster on a Collection of Statistics as to the Physical Condition of Children attending the Public Schools of the School Board for Glasgow, 1907. (Blue Book.) (Heights, weights and housing of over 72,000 school children.)

7. Report issued by Edinburgh Charity Organisation Society on the Physical Condition of 1400 School Children, together with some account of their Homes and Surroundings. (P. S. King & Son, London.) (The most exhaustive investigation of its kind yet published in Britain.)

8. Reports on Examination of 1000 Glasgow Children by Dr. A. K. Chalmers and others. (Transactions of Royal Sanitary Institute, Glasgow Congress, 1904.)

9. Report by Dundee Social Union on 1000 Dundee School Children. (Leng & Son, Dundee, 1905).

10. Annual Reports by Dr. James Kerr, Medical Officer (Education), London County Council.

11. Annual Reports by Medical Officer of Dunfermline Carnegie Trust, 1906 and 1907.

12. Transactions of Nuremberg Congress on School Hygiene, 1904. (Four Volumes.) (Nuremberg: Verlag von J. L. Schrag.)

13. Transactions of London Congress on School Hygiene, 1907.

14. International Magazine of School Hygiene, edited by Sir Lauder Brunton, Dr. Axel Johannessen, and Dr. Herm, Griesbach. (Leipzig: Verlag, Wilhelm Engelmann.)

15. Memorandum on Medical Inspection of Children in Public Elementary Schools, under Section 13 of the Education (Administrative Provisions) Act, 1907; issued by English Board of Education (Circular 576). Model Schedules issued by same Board.

16. General Report on Teaching of School and Personal Hygiene to Students in training in Scotland. (Blue Book, Scotch Education Department.)

17. See also general works on School Hygiene, particularly *Enzyklopädisches Handbuch der Schulhygiene*, edited by Dr. R. Wehmer (Wien and Liepzig, 1904: Verlag von A. Pichlers, Witwe & Sohn), and *Handbuch der Schulhygiene*, by Dr. Leo Burgerstein and Dr. A. Netolitzky (Jena: Verlag von Gustav Fischer).

18. Report by Dr. Crowley, Bradford, On a Course of Meals given to Necessitous Children from April to July 1907. (Full details of diets, increase of weight, menus for each day, cooking recipes, etc.)

Schott's Method. — A method of treating heart disease (myocardial) by Nauheim baths (containing carbonic acid gas) and exercises (resistance gymnastics).

Schräger's or Schreger's Lines. —Curved (undulating) lines in the enamel of the teeth due to the curvature of the dentinal tubes.

Schrapnell's or Shrapnell's Membrane. — The lower part of the tympanic membrane (*membrana flaccida*). *See* Ear, Examination of (*Tympanic Membrane*); Ear, Middle, Chronic Suppuration (*Symptomatology, Perforation, Attic Disease*).

Schroeder's Contraction Ring. *See* Bandl's Ring.

Schuele's Sign.—An arrangement of vertical folds of the skin between the eyebrows, supposed fancifully to resemble the Greek letter omega (Ω or ω) and to be characteristic of melancholia.

Schüller's Method.—A means of performing artificial respiration. *See* Asphyxia (*Resuscitation, Methods*).

Schultze's Fold.—A special fold of the amnion near the root of the cord on the fœtal surface of the placenta, passing to and indicating the position of the relics of the umbilical vesicle (if present).

Schultze's Method.—The swinging movements recommended by B. Schultze as a means of resuscitating still-born babies. *See* Asphyxia (*Resuscitation, Methods*); New-born Infant (*Asphyxia Neonatorum, Treatment*).

Schultze's Tract.—A special tract of descending fibres in the spinal cord (posterior column) which undergoes degeneration after division of the cord and has then a comma shape.

Schumberg's Process.—A method of sterilising water "by adding 1 c.c. of a bromine solution to 5 litres of water, and after 5 minutes' contact neutralising with ammonia water"; it is believed to be effective in destroying the bacillus typhosus.

Schwabach's Test. *See* Ear, Examination of (*Hearing Tests*).

Schwalbach. *See* Balneology (*Germany*); Mineral Waters (*Chalybeate*).

Schwann's Sheath.—The medullary or white sheath of a nerve fibre. *See* Physiology, Tissues (*Nerve, Axon*).

Schwartze's Operation. *See* Ear, Middle, Chronic Suppuration (*Diseases of the Mastoid, Treatment*). The Schwartze-Stacke operation is a modification.

Schweizerhalle. *See* Balneology (*Switzerland*).

Schweninger Cure.—A method of treating obesity resembling Oertel's; it is dietetic (no water being drunk at meals), and is associated with systematic exercise and massage.

Sciacca. *See* Balneology (*Italy, Sicily, Sulphur Waters*).

Sciapody.—Congenital enlargement of a foot; macrosomia of one extremity, or macropodia.

Sciatic.—Relating to the ischium, *e.g.* the sciatic artery, foramen, nerve, notch, plexus, etc.

Sciatica. *See also* Abdominal Aneurysm (*Differential Diagnosis*); Cautery (*Uses*); Electricity (*Uses*); Hip-Joint, Diseases of (*Diagnosis*); Hydropathy (*Uses*); Hysteria (*Sensory Disorders*); Tabes Dorsalis (*Diagnosis*); Surgical Affections (*Injuries of Sacral Plexus*).—An indefinite term applied to conditions associated with pain in the region of the sciatic nerve. This important nerve trunk is the continuation downwards of the main part of the sacral plexus (*see* Spinal Cord). It arises in the pelvis, and enters the buttock through the great sacro-sciatic foramen below the pyriformis muscle, and extends down to about the middle of the thigh, where it terminates by dividing into the external and internal popliteal nerves. In position the main trunk of the sciatic nerve lies rather internal to the mid-point between the ischial tuberosity and the great trochanter of the femur. It supplies muscular branches to the ham-string muscles on the back of the thigh and the main part of the adductor magnus. A knowledge of the course and distribution of its main branches is essential for understanding the diseases of the nerve trunk.

The *external popliteal* nerve passes down into the popliteal space, which it leaves, ultimately dividing into anterior tibial and musculo-cutaneous nerves. The branches of the external popliteal nerve are cutaneous for the outer side of the leg, and also articular. The anterior tibial nerve takes origin opposite the neck of the fibula, and passes down the leg, coming in contact with the anterior tibial vessels in the upper third of the leg, and terminating in front of the ankle-joint by dividing into internal and external branches. This nerve supplies muscular branches to the extensor muscles (tibialis anticus, extensor longus digitorum, extensor proprius, peroneus tertius), and an articular filament to the ankle-joint; the terminal branches are concerned in the supply of the tarsal articulation (external branch) and adjacent sides of first and second toes (internal branch).

The *musculo-cutaneus*, the other terminal branch of the external popliteal nerve, becomes cutaneous by piercing the deep fascia in the lower third of the leg, and almost immediately divides into two branches, internal and external. The internal supplies the skin over the inner side of the great toe and the adjacent sides of the second and third toes, also the skin on the internal malleolus and inner side of the foot; the external branch supplies the skin over the adjacent sides of the second and third, and third and fourth toes, also the skin over external malleolus and outer side of the foot.

The *internal popliteal nerve* passes down through the popliteal space to terminate opposite the lower border of the popliteus muscle, by becoming directly continuous with the posterior tibial nerve. The branches of the internal popliteal nerve are—a cutaneous branch (ramus communicans tibialis), articular branches to the knee-joint, and muscular branches to the gastrocnemius, plantaris, soleus, and popliteus muscles. The posterior tibial nerve is the direct continuation of the external popliteal nerve, and supplies cutaneous branches, articular filaments to the ankle-joint, muscular branches to tibialis posticus, flexor longus digitorum, flexor longus hallucis, and soleus muscles, and finally terminates as the internal and external plantar nerve.

Sciatica is characterised by pain in the back of the thigh in the region of the sciatic nerve, the pain in some cases involving the whole area of distribution of the nerve. The pain is aggravated by certain positions or after exertion, and has its sites of maximum intensity in the middle of the thigh or at the sciatic notch. In chronic cases there may be some muscular atrophy and cramp of the muscles, with localised fibrillary contractions in the muscle fibres.

Etiology and Pathology.—Examination of portions of the sciatic nerve in cases where stretching or excision of pieces of the nerve has been resorted to, has revealed an inflammation of the nerve trunk. The causes of this inflammation are obscure. The poisons of rheumatism and gout are probably the most important factors, and when these are present slight exposure to cold and damp or severe muscular exertion may induce an attack. The *diagnosis* is as a rule easy; it is made by (1) digital examination over the nerve, and (2) putting the nerve on the stretch, which movement causes pain. If the following points are kept in mind little or no difficulty will be encountered:—

1. Pain in the region of the sciatic nerve may be induced by pressure on the nerve within the pelvis, *e.g.* distended rectum, uterine tumour, or pelvic inflammation.

2. A similar pain may be induced by a joint lesion, *e.g.* disease of the hip-joint, or sacro-iliac articulation.

3. A lesion of the cauda equina, or nerve roots, or even a lesion of the cord higher up, may produce symptoms of sciatica. A careful investigation of the sensibility and of the areas of distribution of the lesion will eliminate this.

4. The presence of foci of inflammation of

muscle tissue may induce a clinical picture of sciatica. This is a point of considerable importance, and is apt to be overlooked. Further details on this condition will be found in the article on "Chronic Rheumatism," vol. viii.

The *prognosis* is always guarded as to rate of recovery. The disease is usually a protracted one and not very amenable to treatment. In *treatment* we should be guided by the fact that the disease is usually the local manifestation of a general toxæmia. Hence general treatment is all-important, more especially that devoted to promoting the activity of the organs concerned in elimination—bowels, skin, and kidneys (see "Balneology," vol. i.). The diet should be studied along the lines indicated for rheumatism. The internal administration of sedatives of any kind should be withheld as long as possible, and should opiates be necessary these should only be administered by the physician. In a few cases complete rest in bed with immobilisation in a long splint is the best means of promoting recovery. After the acute stage has passed off massage in various forms is the most valuable line of treatment. Counter-irritation by dry cupping, iodine, acupuncture, or other means is sometimes of benefit, and when the case is very intractable a good result may follow nerve-stretching or excision of a part of the nerve trunk. General tonic treatment is useful, and more especially the internal administration of cod-liver oil and arsenic.

Scilla. *See* Squill.

Scillism.—The poisonous effects due to the use of preparations of squill containing the bitter principle or glucoside, *scillitoxine* (which resembles digitalis in its action).

Scillocephaly.—The deformity of the head in which it has a small, peaked shape, like the bulb of squill (Lat. *scilla*, squill).

Scinde Boil.—Aleppo boil. *See* Furunculus Orientalis.

Scintillation.—A symptom characterised by the appearance of sparks in the field of vision (Lat. *scintillare*, to sparkle), as in attacks of hemicrania. *See* Migraine.

Scirrhous and Scirrhoid.—Hard in consistence, and resembling a scirrhus (Gr. σκιρρος, gypsum).

Scirrhus.—A hard form of carcinoma. *See* Mammary Gland, Diseases of (*Carcinomata*).

Scissor-Leg Deformity.—The deformity, known also as "crossed-leg," in bilateral hip-joint disease, when the lower limbs are adducted and cross each other. *See* Hip-Joint, Diseases of (*Bilateral Hip Disease*); Deformities (*Coxa Vara*).

Scissors. — In surgery and obstetrics various scissor-like instruments are used; *e.g.* Allingham's scissors (for fistula in ano), Naegele's or Smellie's scissors (for craniotomy), and Skene's Hawkbill scissors (for trachelorrhaphy).

Sc.L.A.—The contracted form of scapula-læva-anterior, the left scapulo-anterior position in transverse presentations in midwifery. *See* Labour, Diagnosis and Mechanism (*Transverse Lies*).

Sclera.—The sclerotic coat or white of the eye (Gr. σκληρός, hard), *scleral* meaning relating to this coat. *See* Glaucoma (*Treatment, Scleral Puncture*).

Sclerectomy.— Excision of a portion of the sclerotic or of sclerosed bone.

Sclerema Neonatorum. *See also* New-born Infant (*Sclerema*).—A study of the literature of the strange infantile malady known as Sclerema Neonatorum tends rather to perplexity than to a clear conception of a definite morbid entity. It is difficult to be sure how far the various authors are describing one and the same disease, and whether cases alike in their nature are not sometimes classed under different headings. In this country we are not favourably placed for forming a judgment upon these questions, seeing that with us the disease is so rare that there are few opportunities of bringing the different views which are put forward to the test of practical experience. In some lands, as in Italy and France, on the other hand, sclerema seems to be far less uncommon.

We are constantly warned against confusing sclerema with symptomatic œdema, of the ordinary kind and with the ordinary distribution, occurring in new-born infants; but on the other hand an œdematous variety of sclerema is described, and the more recent writers, adopting a classification long ago suggested by Brissard, divide the cases of true sclerema into two classes, to which the names of fat sclerema and sclerœdema are respectively applied.

Fat sclerema is a symptomatic condition met with in young infants who have been subjected to a drainage of liquid in the course of severe attacks of diarrhœa or vomiting, and the induration of the subcutaneous tissues in such cases is attributed to solidification of the *panniculus adiposus*. As Langer pointed out—and his observations have been confirmed by Knöpfelmacher—the fat of young infants is richer in stearin and palmatin and poorer in olein than that of adults, and therefore solidifies at a higher temperature.

In *sclerœdema*, on the other hand, the induration is ascribed to a peculiar form of firm œdema, due, at least in part, to serous infiltration of the subcutaneous tissues and of the connective tissue between the muscles.

Cases described under the name of sclerema neonatorum for the most part belong to this latter category, but it is acknowledged that the clinical features of the two varieties are much alike; that the two are often hard to distinguish, especially in their later stages, and that they may occur in association.

The infants who suffer from this disease are often premature, or if born at full term have an aspect of prematurity. It has been met with more frequently in the colder than in the warmer seasons, and in children born under unfavourable hygienic conditions than among those of the better-to-do classes. It is specially frequent in foundling hospitals.

The first symptoms usually develop when the child is a few days old, but in some cases the disease is present at birth. The conspicuous signs are a peculiar coldness of the surface, accompanied by a conspicuous fall of the internal temperature; induration of the subcutaneous tissue over a greater or less area; slow respiration, and a slow and feeble pulse.

The skin of the affected parts cannot be pinched into folds, as can that of a healthy infant, and the surface is smooth and tense, and somewhat raised above the level of the surrounding skin. The sclerematous areas feel firm and elastic and seldom pit on pressure. The tint of the skin may be normal or dusky red or even purple, and an icteric tinge is also frequently noted. The pink tint disappears under the pressure of the finger. The induration which is at first localised may remain so, or may spread to parts previously unaffected, until it becomes almost universal.

As a rule the dorsal surface is first involved, the face and ventral aspect become affected later, but even in the worst cases the induration seldom spreads to the front of the chest. Hard patches may be present on the cheeks even in the milder cases, and in severe ones the features may be rendered immobile, and sucking may become impossible.

When induration is very general, rigidity of the limbs becomes a prominent symptom, so that the infant may be lifted as a rigid whole. These features were observed in the earliest recorded case, that of Usenbenzius (A.D. 1722), who described a *fœtus vivus, frigidus et rigidus.*

The fall of the temperature is very conspicuous in such cases, and, according to G. Somma, who regarded it as the essential and primary symptom, may even reach to 23° C. (73·4° F.), but in some more benign cases the same author quotes 35° C. (95° F.) as the lowest limit reached. Such temperatures are obtained in the internal cavities, such as the rectum, and the icy coldness of the surface is often referred to by authors.

Ballantyne states that the pulse rate, which is normally 120 to 150 per minute during the first days of life, may fall to 80 or even 70. At the same time the pulse is extremely feeble, and the heart-sounds may be hardly audible. The respirations may be slowed from the normal rate of 40 to 30 or even 20 per minute. The cry is feeble and has a peculiar squeaky character.

In cases of severe generalised sclerema the prognosis is extremely bad, and death usually occurs within a few days of the onset of the disease, as a rule in the first week of life. From a review of the various published figures Ballantyne concludes that the average mortality is about 50 per cent, but some of the statistics of foundling institutions show a much higher mortality than this.

The favourable prognostic points are limitation of the induration, a not excessive fall of temperature, the absence of pulmonary or intestinal complications, birth in a warm season, and good nutrition and robustness of the infant when born.

In the out-patient departments of our hospitals, cases are occasionally seen which show a localised induration on the back and limbs, most pronounced about the buttocks, and extending in a tapering form down the backs of the thighs and arms, and in which the induration has all the characters assigned to sclerœdema. Such infants usually come under observation when a few weeks old, after the initial fall of temperature and the other constitutional symptoms are things of the past, and when it only remains to watch the gradual resolution of the sclerematous lesions, a process which in the cases which have come under the writer's notice has usually taken some five or six months. The areas of induration gradually decrease in size and break up into discrete islets, which undergo softening, but at no time pit on pressure.

If these be cases of true sclerœdema they are certainly less rare than the fatal cases, at least among the poorer classes in London.

In *fat sclerema* the changes described in the skin and subcutaneous tissues consist in an increase of connective tissue and atrophy of the fat cells, which are always devoid of fat and show conspicuous nuclei. In sclerœdema, on the other hand, a well-marked œdematous infiltration of the subcutaneous tissue is observed. Visceral changes are also met with in fatal cases, such as broncho-pneumonia and atelectasis, subpleural and sub-pericardial hæmorrhages and congestion of various internal organs. Comba lays special stress upon an intense and diffuse affection of the renal tissue, evidenced during life by scanty urine containing albumen and renal elements.

The theories which have been advanced to explain the phenomena of sclerema are many. The earliest observers regarded the induration as inflammatory, and some looked upon it as a kind of erysipelas, others as a special form of inflammatory lesion, and others again as analogous to *phlegmasia alba dolens.*

Some have attributed the onset of the disease to circulatory disturbance, others to pneumonia or other pulmonary lesions, and yet others to affections of the digestive tract. Some excellent observers, including L. Somma, G. Somma, and Ballantyne, although they differ on minor points, agree in regarding an affection of the nervous system, attended by disturbance of the thermotaxic centres, as the primary lesion in sclerema.

More recent investigations have been carried out by Schmidt, Comba, Jemma, and others, which render it probable that it results from septicæmia, not due to any specific micro-organism, but to various bacteria such as the bacillus of Friedländer, streptococci, and staphylococci. Such infection best explains the subserous hæmorrhages, broncho-pneumonia, and other visceral lesions so frequently present, to which too little attention was formerly paid by observers, whose attention was chiefly centred upon the changes in the skin and subcutaneous tissue.

The treatment of sclerema has been largely directed to combating the depression of temperature by warm bottles, friction of the surface, and other means. The use of the incubator appears to be clearly indicated.

Massage, from the extremities upwards, has proved of service, and is strongly recommended by Soltmann. Inunctions of warm oil, of camphorated oil, or of mercurial ointment have also been advocated.

Brandy may be given with the milk, which, when the child is unable to suck, must be given with a teaspoon or by tube. Subcutaneous injections of ether and of citrate of caffeine were employed by G. Somma, and inhalation of oxygen has also been recommended.

Scleremia. *See* Sclerema Neonatorum.

Sclerenchyma. *See* Stools (*Concretions containing Sclerenchyma or Bast Cells*).

Sclero-.—In compound words *sclero-* (Gr. σκληρός, hard) means tough or hard, or, relating to the sclerotic coat of the eye; *e.g. sclerosis, sclero-chorciditis, sclerotome*, etc.

Sclero-choroiditis. — Inflammation of both the sclerotic and choroid coats of the eye. *See* Choroid, Diseases of; Sclerotic, Diseases of.

Sclerocorneal. — Belonging to the sclerotic and corneal layers of the eye.

Sclerocyclotomy.—The operation of division of the ciliary muscle of the eye by Hancock's method.

Sclerodactyly. A disease of the digits, characterised by shortening, deformity, and a waxy appearance; it is allied to sclerodermia (*q.v.*).

Sclerodermia. *See also* Adrenal Glands (*Addison's Disease, Diagnosis*); Alopecia (*Varieties*); Nails, Affections of (*Nail-changes in Sclerodactyly*); Raynaud's Disease (*Symptoms*). —This term is used to define a group of diseases in which the skin becomes abnormally hard and immovable. There are two main types of this disorder; the first known as diffuse symmetrical sclerodermia, and the second as circumscribed sclerodermia.

Diffuse Symmetrical Sclerodermia

This disease is the rarer of the two conditions, and commences as a subacute disorder, or in some cases very gradually and insidiously. In the subacute cases the induration of the skin is preceded by symptoms such as pains in the joints, tingling, etc. Early a feeling of stiffness of the skin in the parts to be affected is noted, and this symptom gradually increases. The skin, usually of symmetrical areas, is now found either to be slightly though firmly œdematous, pitting on firm pressure, or to be indurated. The induration is the final phenomenon of this stage of the disease, and the period of œdema may have been absent altogether. The indurated skin is hard, immovable, incapable of being pinched up between the fingers, and on account of its immobility prevents movement in the parts which it covers. Usually large symmetrical areas are affected in this way, so that the face, neck, upper extremities, and the upper part of the trunk may be completely or more less continuously involved. The upper portion of the body shows the disease most commonly, though it is by no means unknown in the lower extremities.

Early in the disease the appearance of the skin may seem to be but little altered, but on examining more carefully, the normal texture is seen to be changed, the natural furrows and "lines of cleavage" are obliterated, and very often a slight amount of patchy erythema is observed. The edge of the sclerodermic area may occasionally be seen, especially in cases where œdema is present; but in other cases the edge or advancing border cannot be easily distinguished except by palpation. On drawing the fingers across the affected area a pale line is produced by expression of the blood, and the normal colour is only gradually resumed as the vessels fill up again. It is not unusual to see minute dilated vessels, either in lines or in tufts, in various parts.

A peculiar immovable mask or statue-like appearance is early assumed in the disease without apparent deformity; but as the earlier stages of the malady pass over, contraction of the affected skin proceeds, atrophy of the subcutaneous tissue and underlying muscles takes place, and great deformity ensues. The joints of the fingers and hands become permanently flexed, the finger tips are pointed, and

atrophy proceeding further may even result in necrosis of the extremities. In the same way the face, instead of the immobile mask-like appearance which it first possesses, undergoes great disfigurement on account of the contraction of the skin and the atrophy of the underlying parts. The skin is stretched over the bones, the eyelids are everted, the gums shrink from the teeth, which may fall out, the lips become puckered and shortened. Fortunately these changes affect a considerably smaller area than the early stage of œdema or infiltration. The fixation and movement of the joints, the interference with respiratory movements, difficulties in deglutition, as well as the depressing influence of the disorder, interfere most seriously with the health of the patient. The atrophic areas of skin in the later stages can usually be readily distinguished from the healthy skin on account of the alteration in its texture and pigmentation, in many cases they resemble the appearance of old ivory. The skin shrinking down on the underlying structures allows the outline of bones and tendons in the limbs to be distinctly observed.

In a considerable proportion of cases the prospect of at least partial recovery is good. The duration of the disease varies very greatly. In those instances where the onset is subacute the prospect seems to be better than in those which commence insidiously, and in which atrophy of the skin is an early sign. Even when induration has occurred, and the parts have remained quite immobile for months, or it may be years, softening of the hardened skin may occur. So long as œdema or simple induration remains there is still prospect of improvement, but the longer the induration persists there is less likelihood of complete recovery, as the fixation of the parts produces atrophy of the muscles, partial or complete ankylosis of joints, and other destructive changes which produce permanent crippling. In those cases in which atrophy of the skin occurs early or becomes general, symptoms of marasmus, and diminution of vitality owing to impaired nutrition, become pronounced, and the patient readily succumbs to slight intercurrent maladies of the lungs, kidneys, etc.

The very striking features of this disease render it easily distinguishable from one or two affections which simulate it. In sclerema or œdema of the new-born the age of the patient is sufficient in most cases to determine the diagnosis. Sclerodermia may commence in infancy, but more commonly in early youth. It is worthy of notice that occasionally the rare form of cancer "en cuirasse," in which the nodules of growth and infiltrating margin of the disease are sometimes difficult to distinguish, has been confused with sclerodermia.

Treatment.—No specific lines of treatment have had any effect in determining its course or curing the disease. All efforts should be concentrated on protecting the patient against adverse hygienic influences, especially that of cold; the subjects of sclerodermia are especially susceptible to the depressing influences of a low temperature. The food should be arranged so as to allow of nutrition being kept up to the highest standard, and the organs of digestion should be aided in every way. Local treatment by means of gentle friction and massage, with the application of oily substances or simple ointments, is frequently of much advantage.

Circumscribed Sclerodermia

This form of disease is frequently known as morphœa, and in the older terminology as the keloid of Addison.

The lesions make their appearance usually without symptoms, though occasionally sensations of tingling in the areas about to be affected may precede or accompany the induration of the skin. The patient's attention is attracted by these symptoms or by the stiffness of the patch of skin, by the loss of hair, if the scalp is affected, or by simply observing the alteration in the colour and texture of the skin, if the disease attacks a prominent position. The altered skin assumes a stiff, parchment-like texture, and is pinched up between the fingers with difficulty, the affected area is altered in texture, the natural furrows and wrinklings disappear, and it usually assumes a smooth, polished surface. Frequently the pigmentation is also altered, and the affected area may have a light sepia tint, resembling old ivory. In other cases the area of the lesion is whiter than the surrounding skin, and has a glistening appearance. It is not unusual to observe that increase of pigmentation is noticeable in the apparently normal skin surrounding the lesions. The margins are sharply defined, and in different cases the affected areas may be slightly raised above or depressed below the healthy skin, so that an edge or furrow marks its border; in the later stages of the disease more or less depression of the affected area is the rule. In the early stages the borders of the lesion show a peculiar erythema, giving a pink or lilac tint which fades away into the surrounding normal structures. The shape of the lesions vary very much; they may occur as patches of a rounded or oval shape, which are sometimes quite small and numerous, so as to deserve the name of "guttate sclerodermia." In other cases the patches, an inch or two in diameter, are scattered on various parts of the trunk or the extremities. Not unfrequently the lesions have a linear distribution, perhaps more commonly on the extremities, and ultimately give rise to "striæ atrophicæ."

But one of the most characteristic of all the methods of distribution is the appearance of

sclerodermia in bands. These may be multiple, and when numerous occupy considerable areas of the body; they seem to be frequently segmental in their distribution, or in some cases to follow the distribution of individual cutaneous nerves. Thus the position which is not uncommonly occupied by this band-like structure is the distribution of the supraorbital branch of the fifth nerve, commencing narrowly near the supraorbital notch, and extending backwards fan-like over the forehead and vertex. In such cases little patches of sclerodermia may also be noted on parts of the face supplied by other branches of the fifth cranial nerve. On the trunk the bands pursue a course parallel to the ribs, and when multiple a peculiar striped appearance is imparted, owing to the alternating bands of sclerodermic and normal skin. When much disturbance of pigmentation is present the appearance of the patient then becomes very striking. At first the bands of sclerodermia are often raised, in the so-called indurated stage of the disease, they become depressed later producing compression of the underlying structures, as if a strap were firmly passed across them. This becomes especially noticeable when the band of sclerodermia passes over soft structures, as, for instance, the breast. In spite of the striking alteration in the appearance of the skin, sensibility is only slightly, if at all, disturbed; not unfrequently the sweat and sebaceous glands retain a certain amount of activity, though, as a rule, this is much impaired. Patulous orifices of the sebaceous follicles are in certain cases the only disturbance of the glossy smoothness presented by the altered skin.

The progress of the disease is slow, and after the lesion is well formed it usually remains stationary for a long period, probably for years. It may then slowly disappear, the skin regaining much of its normal appearance; but in other cases gradual atrophy develops with permanent destruction of the skin. In some cases retrogression of the diseased areas may take place in one or two years. In the majority of instances the disease is of much longer duration, and patches may make their appearance, and in turn disappear during ten years or more, while in others the skin becomes permanently atrophied.

In certain cases, especially when the sclerodermia is of long duration, degenerative changes make their appearance. Occasionally ulceration of intractable character occurs on the sclerodermic areas, and keratoma and other epithelial degenerations have been observed.

The histological changes affect the corium mainly. Its connective-tissue bundles are hypertrophied, producing an aspect of great condensation of the cutis, without noticeable proliferation of connective-tissue cells except in certain positions. The upper layers of the cutis are especially affected, and the papillæ more or less flattened, while the sweat and sebaceous glands and ducts are compressed and even atrophied if the condensation passes deep into the cutis. Groups of new connective-tissue cells are seen surrounding the skin appendages, and in certain other situations, especially surrounding the small blood-vessels. These vessels, as well as the lymphatic channels, are much narrower, but no signs of true obliterative endarteritis are noted. Surrounding the diseased area the blood and lymph vessels are usually wider than normal. The epithelium may show pigmentation and may be thinned, but otherwise shows little change. The alterations described make their appearance in both types of the disease.

The etiology of the condition is unexplained. It occurs in women much more frequently than in men, and may appear at a very early age, though apparently not in infancy. The majority of cases presenting themselves occur in adolescents or young adults. There can be little doubt that many of the patients showing the disease are of nervous disposition, but whether this is associated with the cause or is simply an effect of the malady is difficult to determine. Depressing influences seem to have less effect in producing the circumscribed variety of the disease than in the case of the diffuse symmetrical type. Its relation to nerve distribution, especially in the band-like variety, which has frequently a typical zosteriform outline, is very suggestive, and has frequently been remarked by clinical observers; but no definite nerve lesion, such as in the case of herpes zoster, has yet been recognised in cases of zosteriform morphœa.

Treatment has very little effect in modifying the cause of an attack of morphœa. General measures to sustain nutrition and to keep the patient in "good condition" should be taken. In some cases regular and gentle massage of the patch of sclerodermia, using a bland oil for the purpose, appears to hasten the resolution of the induration, and to make the skin more pliable, and should certainly be tried. Galvanism and electrolysis have been made use of, but without sufficient success to justify their employment except under very exceptional circumstances.

Sclerœdema. *See* Sclerema Neonatorum.

Sclerogenous.—Causing hardening, or the production of firm tissue.

Scleroma. *See* Sclerema Neonatorum; Scleroderma. *See also* Larynx, Chronic Infective Diseases (*Scleroma of the Larynx*).

Scleronychia. *See* Nails, Affections of the (*Scleronychia*).

Sclerosis.—The induration or hardening of an organ, part, or tissue, due specially to the increase in it of connective tissue; *e.g.* sclerosis of the spinal cord, liver, ovaries, arteries, etc. *See* Ear, Middle, Chronic Non-Suppurative Disease (*Atrophic Catarrh*); Fallopian Tubes (*Salpingitis, Sclerosis of the Tubes*); Fascia (*Diseases, Dupuytren's Contraction*); General Paralysis (*Diagnosis*); Heart, Myocardium and Endocardium (*Special Pathology, Affections of the Myocardium*); Liver, Diseases of (*Cirrhosis*); Lungs, Diseases of (*Fibrosis, Pneumonokoniosis*); Muscles, Diseases of the (*Degenerations*); Nephritis (*Renal Cirrhosis*); Ovaries, Diseases of (*Oophoritis, Cirrhosis of the Ovary*); Paralysis (*Primary Lateral Sclerosis*); Paralysis (*Subacute Combined Degeneration of the Cord*); Paralysis (*Disseminated Sclerosis*); Syringomyelia (*Diagnosis*).

Sclerosis, Disseminated. *See* Paralysis (*Multiple Sclerosis*).

Sclerosis, Multiple.—Disseminated sclerosis, or "sclérose en plaques." *See* Paralysis.

Sclerostoma Duodenale. *See* Parasites (*Nematodes, Strongylidæ, Uncinaria Duodenalis*).

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The sclerotic forms four-fifths of the outer protective tunic of the eyeball, the remaining fifth being covered by the cornea. Although the two structures differ so widely in outward appearance they are histologically very much alike. Each is composed of interlacing bundles of fibres of connective tissue, but in the former there is less regularity of arrangement, and so the opaque whiteness of the one stands out in striking contrast to the perfect transparency of the other. There is, however, no sharp line of demarcation between them, for microscopic examination shows clearly that one passes without break into the other. The sclera is thickest behind, and becomes gradually thinner as the cornea is approached, but localised thickenings occur at the insertions of the ocular muscles. Its weakest parts are at the lamina cribrosa, where the fibres of the optic nerve enter the eye, and at the zone round the cornea overlying the canal of Schlemm. The sclerotic is very poorly supplied with both blood-vessels and nerves, but it is in intimate anatomical connection with all the vascular structures of the eyeball. Externally it is closely related to the blood-vessels of the conjunctiva and episcleral tissue, internally to those of the choroid and ciliary body, and by the fibres of the ligamentum pectinatum it is united to the iris. It is traversed also by numerous vessels and nerves which penetrate it to gain access to the interior of the eye, and by the venæ vorticosæ, as well as by the anterior ciliary veins which pierce it where they emerge on the surface of the globe. Along the course of these blood-vessels and nerves are numerous branched pigment corpuscles, which help to give the structure a bluish colour, and which at times collect and form brownish spots on the white of the eye. When this pigmentation is congenital it usually occupies the circumcorneal region, and has rarely any significance, but when it is pathological it may implicate a considerable area of the sclerotic, and mark the site of a melano-sarcoma of the choroid.

The anatomical connections just mentioned have an important bearing on the pathological relation of diseases of the sclerotic, which are usually secondary to those of the cornea and uveal tract. Idiopathic inflammation is rare, but it does occur, attacking the part between the equator and the margin of the cornea. Two forms of inflammation can be distinguished: first, episcleritis, where the changes are limited to the superficial layers; and, second, sclerotitis, where the middle and deeper layers are involved. In the former the disease causes a good deal of annoyance, but is never serious; in the latter it is dangerous to sight, owing to complications involving the cornea, iris, ciliary body, and choroid.

Episcleritis

This disease occurs most frequently in young adults, especially if they have a rheumatic or gouty constitution. It is more frequent among women than among men, a result probably due to changes connected with menstruation. Attacks often occur regularly at the menstrual period, although the eye is, in the interval, to all appearance perfectly well. Episcleritis is characterised by the occurrence on the sclerotic, close to the margin of the cornea, of a circumscribed elevation of dark red or bluish red colour. This might at first sight be mistaken for a phlycten, but careful examination will show that the infiltration is not in, but beneath, the conjunctiva; moreover, the inflamed patch is always tender to touch, and there is usually more or less aching pain in the brow. The cornea and iris are unaffected. After a few weeks the general congestion diminishes, and the swelling (which is now more bluish than red, and is traversed by a few enlarged and varicose veins) gradually disappears, though usually for some time longer the underlying sclerotic presents a slate-blue discoloration. Episcleritis shows a marked tendency to recur at the same spot, or at some other part of the eyeball, and it may continue to attack point after point, and only pass off after it has

travelled all round the circumference of the cornea, a process which may occupy many months. It may also recur after a lapse of several years, and sometimes the eyes are affected alternately.

Episcleritis periodica fugax—the name given by Fuchs to a condition termed by von Graefe sub-conjunctivitis or tenonitis anterior, and described long ago by Hutchinson under the name of "hot eye"—is a somewhat rare disease. It is generally found attacking persons in middle life, and may be distinguished from the usual form by the absence of typical nodules and of any marked atrophy of the sclerotic. While it is frequently found associated with the gouty or rheumatic diathesis, it makes its appearance in many instances without any very definite ascertainable cause. There is inflammation of the conjunctiva and of the episcleral tissues, and the latter may be considerably swollen. The inflammation may affect one or both eyes, or may confine itself to one part of the sclerotic, or involve the whole area between the equator and the margin of the cornea. Pain, photophobia, and lachrymation always exist, and in severe cases contraction of the pupil and spasm of the ciliary muscle are added. The attack may last for only a few hours, or for several days, and while hot eye always disappears without doing permanent harm, it is, like the ordinary form, very apt to recur.

Opportunities for the study of the pathology of episcleritis have been, of course, far more numerous, but examination of the few eyes available post-mortem has demonstrated that the typical nodules are caused by an infiltration of the superficial layers of the sclerotic, the connective-tissue bundles having become separated by fibrinous and cellular exudation, which shows no tendency to break down, but gradually becomes absorbed. As a result of this process the area of sclerotic affected becomes thinned, and the bluish stain which so frequently marks the site occupied by a nodule is therefore obviously due to the pigment in the underlying choroid. In spite of the protracted course of the disease, which may last for months or even for years, the prognosis is always favourable. The sight is never implicated, nor is any permanent or serious damage ever done to the eyeball.

The chief indications for treatment are to combat the different stages as they arise, and to try to prevent recurrence. As the superficial is only to be distinguished from the deep form of the disease by the absence of iritis and similar complications, it is in every case, in the first instance, wise to instil atropine. If the pupil dilates fully the course is likely to be favourable, no matter how severe and distressing the symptoms may be. The application of a blister to the temple, and the administration of a mercurial, followed by a saline purge at the very outset, will often at once cut an attack short; but if the pain be excessive, and the injection of the eyeball livid in colour, more speedy relief will be obtained by the application of three or four leeches to the outer canthus. The blood-letting should always be followed by the application of fomentations or of the Japanese warmer. In chronic cases atropine continuously used is apt to excite increase in the intraocular tension, and consequently eserine and pilocarpine, combined with cocaine and adrenalin, are more beneficial. Where there is a gouty or rheumatic diathesis, alkalies, iodides, and salicylates are clearly indicated, and when the attack is acute these should be administered in large doses, the patient should be kept in bed, and everything should be done to encourage the free action of the skin.

An acute attack treated in this way usually passes off in a few days, but the slightest exposure to cold or to damp may at any moment bring about a relapse, and it is therefore necessary, even after the recovery seems perfect, to continue the treatment by alkalies and tonics. Indeed, if the patient's circumstances permit, the best results are likely to be obtained by sending him to a spa where the waters are mildly alkaline, and where the climate is dry and bracing. He must also be warned never to expose the eyes to bright light or to cold winds, or to overtax them in reading. As a safeguard against the first two he should be furnished with protective glasses, and against the last by the provision of suitable spectacles if there be any error of refraction. If a lotion be necessary nothing is more soothing than a warm solution of boric acid, to which opium and chamomile have been added, but all eye-washes and ointments containing irritants, such as zinc, alum, perchloride of mercury, etc., are to be avoided. It must never be forgotten that in diseases of the sclerotic the eyes are very intolerant of local applications.

Sclerotitis

This is a very dangerous disease, for although in the early stages the signs are slight, yet its progress is most insidious, and in the long run it is likely to involve all the tissues of the eyeball. Its consequences are all the more distressing from the fact that it very frequently attacks young adults, and usually affects both eyes. Females suffer oftener than males, and those whose constitutions are tainted by scrofula, rheumatism, gout, or syphilis become victims all the more readily. At the outset a few enlarged and varicose blood-vessels appear over the surface of the sclerotic, and at one part the white of the eye quickly becomes bluish, with here and there a thickened patch of porcelain-like appearance. As the diseased area spreads the deeper structures become involved, the iris gets discoloured, and very frequently the intra-

ocular tension is reduced. A subacute or chronic iritis supervenes, the aqueous becomes turbid, and dirty, greasy-looking spots form on the posterior surface of the cornea. The patient's sufferings are usually acute: he shuns the light, the eye waters copiously, and vision is seriously impaired. The inflammation spreads in surface extent as well as in depth. Milky white opacities form on the cornea as if its circumference were, at different points, being overlapped by the sclerotic. These opacities are usually sector-shaped, and the cornea in their neighbourhood is always more or less inflamed. After an acute attack passes off the transparency may be so far recovered that vision improves, but the sclerotic has changed considerably in appearance, and patches of a dark-blue slate colour are visible round the cornea.

The pupil becomes contracted and is occasionally displaced, the base of the iris is pushed against the posterior surface of the cornea so that the anterior filtration spaces become obliterated, and the eye is liable to attacks of acute glaucoma. The increased intraocular tension reacting on the weakened sclerotic, causes it to bulge forward to form a staphyloma.

This (in the first instance usually partial) is situated immediately behind the corneal margin, around which are elevations—multiple staphylomata—blue in colour, owing to the pigment of the choroid shining through. These ectasiæ may be situated over the ciliary processes (when they show as dark streaks), but more usually they lie a little farther forward, their site corresponding to the zone between the cornea and the root of the iris. In the former case they are spoken of as ciliary staphylomata; in the latter, as interciliary staphylomata. A further stage in the progress of the disease is marked by increased secretion of fluid into the vitreous. This gives rise to still greater tension, which the parietes of the globe already weakened are unable to withstand, and consequently the eyeball becomes distended in all its diameters, and a certain amount of exophthalmos is produced. In most instances the cornea is by this time opaque and enlarged, and its curvature so altered as to make it seem almost continuous with the attenuated sclerotic. A somewhat similar condition of things occasionally develops during the early years of life, and gives rise to buphthalmos, though the earliest stages of this disease probably always occur *in utero*.

Sclerotitis may go on for many years—being thus one of the most tedious of ailments—and, unfortunately, little can be done in the way of treatment. While the distress incident to acute attacks may be, to a great extent, relieved, remedies are of little avail in arresting the steadily downward course of the disorder. Under favourable conditions a remission in the symptoms may be obtained, but the improvement is rarely permanent, and a very slight cause serves, in predisposed subjects, to determine a relapse. After each recurrence vision deteriorates more and more, and owing to the appearance of acute attacks of secondary glaucoma, the sufferings of the patient are, especially in the later periods, very severe.

In the early stages in particular, care must be taken not to adopt any routine method of treatment. Every case must be carefully examined on its own merits, in order to find out not only the amount of damage which has been done to the eye, but also, if possible, the cause of the inflammation. Probably in every instance sclerotitis primarily originates in some morbid constitutional state, but it is often exceedingly difficult to determine the true nature of the dyscrasia. Where cases are undoubtedly due to scrofula, rheumatism, gout, or syphilis, the all-important indication in treatment is to prescribe remedies directed against the particular diathesis from which the patient is suffering. Naturally one thinks of iodides, mercury, alkalies, iron, cod-liver oil, maltine, etc., and occasionally the prolonged administration of these does much to hold the disease in check. In other cases, however, such a line of treatment seems to do harm, by disordering digestion and interfering with the proper assimilation and metabolism of food. It is always of the first importance to maintain nutrition at the highest possible level, and hence the value of careful dieting, and of placing the patient in the best hygienic surroundings. Even when, however, by these means an improvement in general health has been effected, the eye-condition often shows no signs of improvement, because the ocular changes have advanced so far, and are of such a nature as of themselves seriously to imperil the nutrition of the eye.

Acute symptoms nearly always arise from increased intraocular tension, brought about by the blocking of the anterior filtration spaces through pathological changes occurring in the iris and ciliary body. One of the most reliable guides, therefore, in the treatment of an individual case is the careful estimation of the tension of the eyeball. In the early stages acute symptoms must be met and dealt with in the manner previously described when speaking of episcleritis; but in the later stages, when severe complications have occurred, leeches, fomentations, myotics, and morphia may all fail to afford any permanent relief, and then surgical treatment becomes necessary. One of the simplest, as it is one of the safest methods of operating in such cases, is to puncture the sclerotic as far back as possible with a broad needle, so that some of the contents of the eyeball may escape. This has the effect of immediately lowering the tension, and relieving the pain, and the respite thus gained is often of considerable duration. When the cornea is seriously implicated, and blood-vessels are seen

to enter its substance from the periphery, the excision of a circumcorneal ring of conjunctiva tends, by cutting off the abnormal vascular supply, to facilitate the disappearance of nebulous opacities, and so to improve the sight. At other times the excision of a piece of iris opposite the clearest part of the cornea not only reduces the intraocular tension, but forms, at the same time an artificial pupil, thereby restoring a measure of sight to an eye which had till then been practically blind. The incision must be made as much in the sclerotic as possible, and the iris separated completely from its ciliary attachment, care being afterwards taken that its cut edges are in no way caught in the lips of the wound. In sclerotitis, however, it is not wise to perform an iridectomy until all acute inflammatory symptoms have passed away, because if the operation be premature it may aggravate matters, and be speedily followed by a rapid distension of the eyeball. Scleral paracentesis and peritomy are, on the whole, the safest operations, as they can be repeated again and again, and are never likely to do any harm. Unfortunately, however, in the steady downward course of events the time comes when sight is altogether lost, and then, in order to relieve the patient from intolerable suffering, the disorganised eyeball must be enucleated.

Injuries of the Sclerotic

Wounds of the sclerotic may be divided into lacerated, incised, and punctured.

Those of the first class are the result of a blow, which causes a rupture of the sclera—most frequently at the upper and inner aspect of the globe, and concentric to the corneal margin. The part of the sclera which bursts is that which overlies the canal of Schlemm, from two to three millimetres from the margin of the cornea. A blow severe enough to rupture the eyeball always causes damage to the deeper parts. Very frequently the lens is dislocated and extruded. The conjunctiva is, however, so elastic that it may not give way, and the dislocated lens is therefore seen lying beneath it. The iris is displaced backwards, and the part opposite the wound passes out of sight altogether, leaving a gap resembling that resulting from an iridectomy. There is always considerable effusion of blood into both the anterior and the posterior chambers of the eye. In other cases the rupture may be very much more extreme, the worst examples being seen in persons who have been severely assaulted, or whose eye has been struck by a cow's horn. In such instances there is a wide rent in the sclerotic, a large escape of the clear structures takes place, and the choroid and retina are seen hanging from the lips of the wound. The eye is filled with blood, which often forms a thin layer behind the cornea, giving rise to the appearance of a pupil, though no pupil is there. The blood may infiltrate the substance of the cornea, and always causes discoloration of, and a great amount of swelling in both conjunctiva and lids.

Incised and punctured wounds are inflicted by some sharp instrument, *e.g.* a knife, scissors, a fork prong, a pen, a piece of glass, a chip of metal, a bullet, etc. The great danger when a wound has perforated the sclera is, that the instrument which caused it may at the same time have infected the eyeball. Aseptic wounds are to be found only after carefully performed surgical operations; all other wounds may be regarded as septic. The injury to the sclera may, in a case of puncture, be very slight—so slight, indeed, as to be completely hidden by conjunctival ecchymosis—yet micro-organisms have been conveyed into the interior of the ball, and in a few days the eye is entirely destroyed by suppuration. The difficulty in the diagnosis of these seemingly trivial cases will be considerably lessened if care be taken to examine the tension of the globe. Whenever there is an opening in the sclera the intraocular tension is markedly diminished.

Incised wounds, usually self-evident in themselves, are, besides, accompanied by a prolapse of the ciliary body of choroid, and by escape of the vitreous. If they be extensive—and more particularly if the ciliary region be involved and the escape of vitreous be large—the eye will be almost certainly lost, because, even although the wound heal kindly, there is always subsequent inflammation of the uveal tract; and this leads to shrinking of the globe, and possibly to sympathetic inflammation. When the injury has been caused by a knife, fork, or pair of scissors, the chances of the presence of a foreign body are very remote; but when it has been inflicted by a chip of metal, of stone, or of glass, by a splinter from a percussion cap, or by a bullet, the case is very different. Under these circumstances the probability that a fragment of the substance has lodged inside is very great indeed, and this makes matters all the more serious. If the patient be seen immediately after the accident the foreign body may be detected in the vitreous chamber by means of the ophthalmoscope; but should any little time have elapsed between the infliction of the injury and the examination, the foreign body will be concealed either by blood-clot or by the inflammatory exudation which its presence has induced. Here the Röntgen rays become at once of the utmost value, for, although careful inquiry into the history of the accident and accurate observation of the nature of the wound may afford much information, yet the presence or the absence of an extraneous substance can rarely be determined with certainty otherwise than by the existence or non-existence of an image on the photographic

plate or on the fluorescent screen. In this way, also, if a foreign body be present, its exact position may be definitely settled, and the extraction rendered all the more easy.

In dealing with wounds of the sclerotic such examination and determination are essential preliminaries. If no foreign body be present the chances of preserving a serviceable eye will depend very largely upon the site and extent of the injury, the amount of the loss of vitreous, and the risk of septic infection. The wound should be carefully cleansed by copious douching with solution of boric acid, and the skin of the eyelids and surrounding parts of the face thoroughly disinfected. Any prolapse of the contents of the globe must be carefully cut away, and the lips of the wound in the sclerotic drawn together by sutures passed through the conjunctiva. To suture the sclera itself would be both difficult and dangerous, and is quite unnecessary. The most recent pathological researches have shown that in the process of healing the sclera may be regarded as passive, union being effected by the reparative changes which take place both in the episcleral tissue and conjunctiva, and in the choroid opposite to the wound. If there be subconjunctival dislocation of the lens the conjunctiva covering it must be incised to allow the lens to escape, and the edges of the incision brought into accurate apposition by silk sutures. The wound should then be dusted with finely powdered iodoform and boric acid, the eye carefully bandaged, and the patient put to bed. An icebag should be applied for the first twenty-four hours to relieve pain and subdue inflammation. When a foreign body is present, endeavours must be made to extract it. If it be a chip of iron or of steel, its removal will be greatly facilitated by the employment of the electro-magnet; but should it happen that the substance is one which the magnet will not attract, an attempt must be made to grasp it with forceps after its position has been accurately localised by means of the X-ray apparatus. After the foreign body has been removed, the wound should be treated in the manner just described as suitable for simple incised injuries. If the injury be extensive and the eyeball collapsed through loss of vitreous, or if attempts to extract a foreign body have been unsuccessful, the wisest plan is to enucleate at once, so that the patient may be saved much suffering, and the risk of sympathetic inflammation may be avoided.

Staphyloma

Staphylomata of the sclerotic are due to a disturbance between the intraocular tension and the resistance of the scleral tissue. Whenever the former is increased or the latter diminished an ectasia of the sclera gradually takes place, and the bulging may be either total or partial. Total staphyloma only occurs in infancy or early youth, and may be congenital. It leads to a uniform distension of the whole eyeball, and is usually described as hydrophthalmos, buphthalmos, or infantile glaucoma. Partial staphylomata, according to their site, are distinguished as anterior, equatorial, or posterior, the last named being visible only by the aid of the ophthalmoscope. Anterior and equatorial staphylomata begin as small dark spots, which enlarge and become darker in colour as the sclerotic becomes thinner, and so allows the pigment of the choroid to shine through it. They may attain to such a size that the eyeball cannot be covered by the lids, and in consequence of exposure it is very liable to inflammation or to suffer from injury. Such eyes are frequently attacked by internal hæmorrhage, and may occasion much pain. A slight blow or any strain consequent on any unusual effort may induce rupture, followed by escape of the vitreous and bleeding from the choroidal vessels. The collapsed eyeball may shrivel quietly, but it may become infected, and then panophthalmitis is almost sure to occur. In the early stages, when intraocular tension is high, an iridectomy operation may arrest the progress of the disease, but whenever sight is lost and the eyeball much distended it is wisest to enucleate.

Sclerotic or Sclerotinic Acid.—An amorphous substance ($C_{12}H_{19}NO_2$?) obtained from ergot (*q.v.*); it is now regarded as a mixture of sphacelinic acid and cornutine.

Scleroticectomy. — The making of an artificial pupil to the eye by the excision of a portion of the sclerotic.

Sclerotico-. — In compound words *sclerotico-* means relating to the sclerotic coat of the eye; *e.g. sclerotico-choroiditis* (inflammation of the sclerotic and choroid), *sclerotico-staphyloma* (staphyloma of the sclerotic), *sclerotomy* (incision of the sclerotic coat). *See* Choroid, Diseases of (*Sclerotico-choroiditis*), etc.

Sclerotitis. *See* Sclerotic, Diseases of (*Sclerotitis*); Gout (*Irregular Gout, Eye Changes*).

Sclerotium. *See* Micro-Organisms (*Hyphomycetes, Sclerotia*).

Sclerotomy or Scleroticotomy.—The incision of the sclerotic coat, anterior or posterior, as in glaucoma; the knife used is called a *sclerotome*. *See* Glaucoma (*Treatment, Operative*).

Scolex.—Scolex (plur. *scolices*) is the name given to the head of a tapeworm (Gr. σκώληξ, a worm); so, by extension, inflammation of the

worm-shaped appendage (appendix vermiformis) has been called *scolecitis* or *scolicoiditis*, and excision of the appendix, *scolectomy*. *See* Hydatid Disease (*Development, Formation of Scolices*).

Scoliosis. — Lateral curvature of the spine (Gr. σκολιός, crooked); and formed from this word are such compounds as *scolio-lordosis, scolio-rachitic, scoliosiometry*, etc. *See* Spine, Surgical Affections of (*Lateral Curvature*); Chest, Deformities of (*In Scoliosis*); Deformities (*From Spinal Paralysis*, etc.); Hip-Joint, Diseases of (*Coxa Vara*); Labour, Precipitate and Prolonged (*Pelvic Deformities, Kypho-scolio-rachitic Pelvis*); Paralysis (*Spastic, Clinical Aspect*); Paralysis (*Infantile Hemiplegia*); Syringomyelia (*Scoliosis and Kyphosis*).

Scoop.—A spoon-shaped instrument for removing pieces of bone, for scraping the uterine cavity, or for extracting foreign bodies from the body cavities or canals.

Scoparii Cacumina.—Broom tops. *See* Broom Tops.

Scoparina. *See* Alkaloids (*Vegetable*); Broom Tops.

Scopolamine. — An alkaloid ($C_{17}H_{22}NO_4$) isomeric with cocaine; hyoscine; combined with hydrochlorate of morphine, scopolamine hydrobromate has been used subcutaneously to produce anæsthesia in surgery and obstetrics, and may be associated with lumbar anæsthesia (with novocaine or stovaine); scopolamine has also been employed in hyperemesis gravidarum, in paralysis agitans, etc.; scopolamine hydrobromide has been employed as a mydriatic in ophthalmology.

Scorbutus. *See* Scurvy, Infantile; Scurvy in Adults; Dysentery (*Complications, Scorbutus*); Ulcers and Ulceration (*Due to Constitutional Causes, Scorbutus*).

Scorpions. *See* Myiasis (*Scorpions*).

Scorpœnidæ. *See* Snake-Bites and Poisonous Fishes (*Fish*).

Scotch Broth. *See* Invalid Feeding (*Soup Making*).

Scotland. *See* Balneology (*Great Britain, Strathpeffer*, etc.); Therapeutics, Health Resorts (*Scotch*); Medicine, History of (*Cullen, Brown*, etc.); Medicine, Forensic (*Procedure in Scotland*); etc.

Scotodinia.—A clinical symptom consisting in the occurrence of vertigo with the appearance of black spots floating, as it were, before the eyes (Gr. σκότος, gloom, δῖνος, an eddy or whirl). *See* Vertigo.

Scotoma.—A region in the field of vision from which rays of light are not perceived, either entirely (*absolute scotoma*) or partially (*relative scotoma*); it is due to a lesion of the retina or of the ophthalmic centres in the brain; other varieties are *central scotoma, ring scotoma, scintillating* or *flittering scotoma*, and *colour scotoma* (localised area of colour-blindness). *See* Amblyopia (*Toxic, Tobacco Scotoma*); Choroid, Diseases of (*Coloboma, Plastic Choroiditis*); Eye, Clinical Examination of (*Examination of Visual Fields*); Vision, Field of.

Scotometer. An instrument for measuring scotomata. *See* Eye, Clinical Examination of (*Field of Vision*); Vision, Field of (*Examination*).

Scotopsia.—The symptom characterised by the appearance of black spots (*muscæ volitantes*) in front of the eye.

Scototherapy.—The treatment of disease by darkness; it has been employed in malaria.

Scott-Moncrieff Filter.—A filter bed through which the sewage passes by upward filtration; the effluent from the top is then passed downwards through trays filled with coke. *See* Sewage and Drainage (*Methods, Upward Flow Cultivation Tank*).

Scott's Dressing. A mixture of *unguentum hydrargyri compositum* (Scott's Ointment) with *emplastrum picis* on leather; it is used in chronic affections of joints.

Scott's Ointment. — Unguentum hydrargyri compositum. *See* Mercury.

Screaming. *See* Meningitis, Tuberculous (*Symptoms*).

Screw Worm.—*Lucilia macellaria*, one of the Diptera, whose larvæ constitute a variety of Myiasis. *See* Myiasis.

Scrivener's Palsy.—Writer's cramp. *See* Neuroses, Occupation.

Scrobiculus Cordis.—The pit of the stomach, or epigastric region (Lat. *scrobs*, a ditch).

Scrofula.—A term not now used in an exact sense, but indicating a variety of tuberculosis, or the condition of body predisposing to infection with the tubercle bacillus; struma. *See* Tuberculosis; *see also* Lung, Diseases of (*Tuberculosis*).

Scrofulo-.—In compound words *scrofulo-* (Lat. *scrofa*, a sow) means relating to scrofula or tubercle; *e.g. scrofuloderma* (tuberculosis of the skin), *scrofulo-tuberculosis* (an attenuated form of tuberculosis), *scrofulophyma* (another name for scrofuloderma), etc. *See* Skin, Tuber-

culosis of (*Scrofuloderma*); Cornea (*Phlyctenular Ulcer, Scrofulous Ophthalmia*); Nails, Affections of (*Scrofuloderma*).

Scrotal.—Belonging to the scrotum (*q.v.*).

Scrotum and Testicle, Diseases of the.

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Anatomy of the Scrotum.—The scrotum forms the purse-like investment for the testes and part of the spermatic cords. It is marked into two lateral halves by a median ridge — the raphé—and each half consists of the following layers: skin, superficial fascia, dartos tissue, intercolumnar fascia, cremaster muscle and fascia, infundibuliform fascia, and outer layer of the tunica vaginalis. The skin of the scrotum is thin, pigmented, and contains peculiar sebaceous follicles. The dartos tissue is subcutaneous, and is continuous with the superficial fascia of the groin, perineum, and inner side of the thighs. It is free from fat, very vascular, and owes its contractility to the presence of much unstriped muscular tissue. It forms two distinct sacs for the corresponding testis, united together along the middle line to form the median partition—the septum scroti. The arteries of the scrotum are derived from the two external pudic arteries and the superficial perineal branches of the internal pudic. The veins accompany the arteries. The lymphatics pass into the inguinal lymph glands, and the following nerves are to be found: ilio-inguinal, ilio-hypogastric, superficial perineal, inferior pudendal, and the genital branch of the genito-crural.

Contusions of the Scrotum.—Owing to the looseness of the scrotal cellular tissue, subcutaneous hæmorrhages resulting from contusions are often followed by the escape of a large quantity of blood beneath the skin and dartos. In this way large hæmatomas may be formed, and may easily be mistaken for vaginal hæmatocele. Such blood collections are best left alone, unless they inflame and suppurate, when they must be opened and drained in the ordinary way.

Wounds of the Scrotum may open the tunica vaginalis and expose or injure the testicle. They must be made scrupulously clean, and the tunica vaginalis closed by sutures and temporarily drained if necessary.

Abnormalities.—*Cleft Scrotum.*—The scrotum is sometimes congenitally cleft, so that the testes lie in a separate bag on either side. This condition results from a failure of union between the two sides of the external genital folds from which the scrotal tissues are developed. It is usually associated with other deficiencies in the genitalia, such as hypospadias, and is mistaken at times for a form of hermaphroditism.

Œdema of the Scrotum.—The loose tissue of the scrotum renders it liable to œdema. Often met with in newborn and young children, resulting in them from some slight irritation of the skin, and usually subsiding under careful attention to keep the part dry and powdered. In weakly children it may pass into a spreading erysipelatous condition, which is occasionally fatal. In after life it is easily induced by inflammation and suppuration of adjacent parts, especially abscesses connected with the urethra; sometimes it is the early attendant on general dropsy, resulting from diseases of internal organs—heart, kidneys, liver, etc. It is usually dependent on some cause—generally local—and subsides when that cause is removed. Great relief may be afforded, and sloughing prevented by puncturing the parts at various points. These punctures allow the serum to drain away, and are much safer than incisions.

Inflammation.—*Erysipelas.*—Its loose structure and pendulous position renders the scrotum an easy prey to inflammation, erysipelatous or other, which is apt to be excited by slight causes, such as small wounds or abrasions, neighbouring abscesses, ulcers, and eruptions or fistulæ. In other cases there is no apparent cause for the attack. In whatever way originating, the affection is a dangerous one, occurring as it often does in patients in poor health, intemperate, ill-fed, or the subjects of visceral disease; it is very prone to run on into diffuse suppuration, with sloughing of the skin and subcutaneous tissue. Another very important point in reference to these cases of erysipelatous inflammation of the scrotum is that they are liable to be mistaken at first sight for extravasations of urine, but that the inflammation depends on some defect of general health or local cause is shown by the facts that the patients have, previously to the attack, experienced no difficulty in micturition, and that a large bougie can be easily passed into the bladder. When suppuration takes place it is

usually diffuse, and may be recognised by the hard feel and the angry appearance of the part, added to the dry tongue and low feverish state of the patient. Abscess is rare in the scrotum.

Treatment.—Dusting with dry powders—boric acid, zinc, and starch powders, etc.—may be tried at first, but when these fail to give relief moist applications must be substituted. Where warm fomentations, rest, etc., do not cause a diminution in the swelling, numerous small punctures should be made early. Where the swelling is already great, the scrotum tense and glossy, its tissues and those of the penis brawny and œdematous, where there is any discoloration of these parts, especially when they tend to become ashy grey, incisions must be made freely, and alcohol, carbonate of ammonia, and bark, with light nutritious diet, liberally administered. But in spite of the above, it is not uncommon for these patients to pass into a condition of increasing asthenia which finally ends fatally.

Gangrene.—The above-mentioned acute cellular erysipelas of the scrotum may soon involve the whole part in gangrene. The tissues of this region have no great degree of vitality. Gangrene also occurs after prolonged fevers in children recovering from one of the exanthemata.

Treatment.—In addition to the treatment already detailed, special attention must be given to the process of separation of sloughs, which may be hastened by the constant application of charcoal poultices, and by the regular snipping away of loose parts which are hopelessly necrosed. The testes rarely if ever perish; they may become completely exposed and deprived of every vestige of their scrotal coverings, but they cover in and heal over in a remarkable manner, the resulting cicatrix being quite insignificant after such an extensive and serious-looking condition.

Emphysema of the Scrotum.—Air or gases in the scrotal tissues are seen in connection with acute gangrene either due to erysipelas or ordinary extravasation: the gases are products of decomposition evolved by certain species of putrefactive organisms. Emphysema is occasionally seen after wounds of the part, and calls for no particular treatment.

Prurigo Scroti.—This affection occurs chiefly in elderly people, and consists of a number of solid lichenous papules upon the skin of the scrotum, chiefly on those parts of the scrotum which are opposed to the thighs and penis; the skin is usually slightly thickened and is marked by scratching. It is extremely obstinate, and its exact nature is often obscure. It is sometimes connected with a diathetic condition, such as gout, and is aggravated by uncleanliness. Its treatment is chiefly local, and dry powdery applications—such as oxide of zinc, calomel, and powdered starch—appear to suit it best. The cyanides, chloroform, tar, and the mercurials may be used to allay the distressful itching.

Pruritus of the genitals may depend upon other local conditions, such as eczema, intertrigo, and pediculi, and these must be treated by the methods found most serviceable for these affections on other parts of the body.

Eczema of the scrotum is a troublesome affection giving rise to great pruritus and irritation. The more chronic forms occur amongst workers in tar and paraffin, and also in chimney-sweeps, being due to the constant irritation of the corrugated integument of the scrotum by dirty clothes. This condition may run on to epithelioma. It is best treated by cleanliness and dusting with dry powders.

Scrotal Eruptions in Secondary Syphilis.—These occur under two distinct forms: (1) Mucous tubercles, and (2) Psoriasis.

Mucous tubercles occur as raised, flattened, roundish, moist grey patches either at the part of the scrotum near the root of the penis, *i.e.* where the penis overhangs it, or at the sides of the scrotum where the thighs come in contact with it. They are seen during the ordinary period of the secondary stage, and are curable by frequently dusting with calomel and oxide of zinc in equal parts.

The psoriasis form is a later secondary, and has peculiar characters in this region. It takes the form of irregular rings, which extend slowly and intersect each other in all directions. The rings are formed by slight thickenings of the skin, about a quarter of an inch in width, slightly raised and red in colour; the redness is covered, except at its extreme edges, by a thin layer of white scale, which is wrinkled transversely to the circumference of the circles. They are sometimes the only skin syphilide present. Itching is often complained of. They are best treated by weak mercurial ointments made with benzoated lard, and *not* vaseline. Dry powders are also suitable applications. They disappear under the general treatment suited to secondary syphilis. *Gonorrhœal* warts are occasionally met with on the skin of the scrotum. They are papillary, "branching," multiple, moist, and offensive, and may be cured by dusting with calomel, painting with tincture of iodine, or snipping away with scissors down to the corium.

Scrotal fistulæ are usually due to the bursting of abscesses in connection with the urethra. They are frequently multiple, and may occur at any part of the scrotum. A history of the conditions which precede them, and a determination of the causes upon which these depend, will indicate the treatment appropriate to each case; for when their cause or causes are removed the fistulæ themselves heal without any special treatment.

Scrotal sinuses are often seen in connection

with tubercular diseases of the testis, and occasionally with syphilitic disease of the organ. Their cure can be effected only by getting rid of the necrotic foci which give rise to them.

Scrotal Calculi.—These consist either of uric acid or of phosphate of lime, and are formed by deposition from the urine, either within the urethra or along a fistulous track. They have been met with in some cases of large size, after many years of existence and growth. Having made their way by ulceration through the urethra, they increase by the deposition of salts from the urine which escapes through the urethral fistula. They may be removed through a simple incision made over them, and steps taken to close the opening into the urethra so as to prevent the formation of future calculi in the same situation.

Tumours of the Scrotum. - Of the non-malignant tumours of the scrotum mention need only be made of:—nævi, which should be excised as soon as it is evident their removal is indicated; cysts, usually sebaceous, which may be removed in the ordinary way; lipomata, fibromata (which sometimes attain a very large size, and may contain cartilaginous, myxomatous, or sarcomatous elements), and chondromata. Sequestration dermoids (Bland Sutton) arise in detached or sequestrated portions of surface epithelium, chiefly in situations where, during embryonic life, coalescence takes place between skin-covered surfaces. In the scrotum this coalescence is in the middle line. They contain putty-like material, in which are usually a few hairs, and are lined with stratified epithelium; in their walls papillæ and sebaceous glands are found.

The treatment of any of these non-malignant tumours is removal by operation.

Epithelioma of the Scrotum, or Chimney-Sweep's Cancer.—Epithelioma of the scrotum is almost entirely confined to chimney-sweeps, and is more common in this country than in others. It occurs, however, in other than sweeps, especially in those whose occupation favours the saturation of their clothes with some irritant. Thus it has been noticed among the employés at gas-works, tar-works, and chemical manufactories. The skin of chimney-sweeps is very commonly encrusted with scaling and indurated patches. In many of them, even when they are thoroughly clean, the whole skin is dry, harsh, and dusky, and before operation for the removal of scrotal cancer in them, it is a common question whether one or more warts and scaly patches near the chief disease should be removed with it. Nor are such warts confined to the scrotum, they may exist on every part of the trunk and limbs

In its origin, structure, course, and implication of adjacent glands, without involving more distant regions, it corresponds with epithelial cancer of the skin in other parts, it is slow in its progress and early in its invasion of lymphatic glands. It commonly begins as a soft, small tubercle or wart in the scrotum. This tubercle appears to be of simple nature, and may remain for a long time without change, only increasing very slowly. Sooner or later it becomes indurated, spreads, and is covered with a crust; and when the crust is removed it bleeds a little. Subsequently it ulcerates, and an uneven, open, cauliflower-like surface is formed, discharging thin bloody fluid, and having a sinuous everted or inverted edge, with a large tuberous margin and an indurated base. Other forms in which this disease may originate are horn-like excrescences, or subcutaneous nodules over which the skin may be thin and adherent, but not otherwise affected. In such cases the epithelioma has probably commenced in the sebaceous glands or hair follicles. Finally, the affection may start from one of those moles which are met with in the pigmented skin of the scrotum. In whatever way the disease begins, ulceration of a malignant nature is sooner or later certain. It then goes on spreading until the whole scrotum is destroyed, and occasionally the crura of the penis and the thickened tunica vaginalis or even the testicles themselves are exposed. Before this, however, the inguinal glands become indurated, subsequently they soften and break, forming excavated cancerous ulcers which spread until the patient is exhausted by the discharge and pain. Often a large vessel in the groin gives way and hæmorrhage shortens the patient's sufferings. The lumbar glands and abdominal viscera are not as a rule involved.

Treatment.—The only treatment is by excision, which must be early and freely done. In very early cases only complete cure by operation is to be expected, and should recurrences occur, they should at once be removed, so long as it is possible to get well beyond the limits of disease, even although the testes and the penis may have to be sacrificed. Enlarged inguinal glands should be at once removed, and by clean, careful dissection all the fat and connective tissues adjacent to them should be cleared away. It is important in following a chain of inguinal glands to remember that the course of their efferent vessels is inwards along the groin, and then downwards from the groin into the femoral triangle—usually through the saphenous opening—from whence they pass upwards by the side of the femoral vessels, through the femoral canal, and accompany the iliac vessels to the back of the abdomen. If operation is deferred until ulceration of the glands has set in, it will usually be useless and disappointing. In inoperable cases of cancer of the scrotum with ulcerating inguinal glands, the friends of a patient should always be warned that hæmorrhage is likely to occur, for it is the commonest cause of death in these cases.

Other forms of malignant tumours of the

scrotum are rare, but the following have been described: encephaloid and scirrhus carcinomas, chondro- adeno- and melanotic sarcomas.

Elephantiasis Scroti.—This is a lymphatic affection mainly of the skin and subcutaneous tissues, and is of the same nature as the Barbadoes leg. It is rarely seen in Europe or North America, and is chiefly found in India, Arabia, China, West Indies, Syria, the delta of the Nile, and other hot countries.

It is a chronic inflammatory disease associated with much œdema, set up by repeated attacks of erythema, and resulting in chronic hypertrophy of the skin and cellular tissue. This seems to be due in some cases to obstruction of the scrotal lymphatics by the filaria sanguinis hominis. In other cases simple inflammatory matting, or cicatricial contraction of the lower abdominal lymphatics, or of the thoracic duct itself, may occasionally give rise to the disease. Syphilis has been said to originate the condition sometimes, but this is by no means certain.

Elephantiasis appears to consist primarily in an inflammatory hyperplasia of the cellular elements of the connective tissue, the roots of the lymphatic vessels being specially involved. Inflammatory overgrowth of the elements of the lymphatic glands next ensues, with obstruction to the passage of lymph through them. Then this fluid stagnates in the lymphatic vessels, which sometimes dilate even to their radicles in the cutaneous papillæ, and accumulates in the interstices of the affected tissues, adding to their bulk, and at the same time stimulating them to overgrowth. It is only in the early stage of the disease that the dilated condition of the lymphatics admits of ready detection. At a late period the morbid tissues are characterised mainly by a dense accumulation of white fibrous tissue. The lymphatic glands also after a time become the seat of fibroid change.

In some cases of elephantiasis scroti groups of vesicles appear here and there on the affected surface, and discharge considerable quantities of lymph, which coagulates after its escape, and is either transparent or milky from the presence of molecular fat.

When elephantiasis attacks the scrotum the part becomes hot, swollen, and tender. The pain is not limited to the scrotum, but is felt along the inner side of the thigh and at the groin. The form of the tumour is conical, having its apex above and base below. As the constitutional symptoms which usher in the complaint subside, the swelling decreases to a certain point, and with the recurrence of another attack similar symptoms return, and a corresponding accession is given to the size of the tumour, which may at length reach to the knees. Unless the swelling be great it usually preserves its form; the penis is concealed in its large folds. Sometimes the raphé deviates from the middle line; cracks are seen from the skin being suddenly and tightly stretched. Abscesses occasionally arise in different parts of the scrotum. It sometimes happens that during the febrile paroxysm a clear discharge exudes from the skin of the scrotum. This is looked upon as a favourable sign. Elephantiasis is frequently connected with hydrocele. Sometimes mortification happens in the skin, and the subcutaneous tissue sloughs, exposing the testes. The chief—almost the only—inconvenience is the dragging and great weight. The scrotum attains enormous proportions, its weight amounting sometimes to more than 150 pounds.

Treatment.—In the early stages strapping with mercurial ointments, and the use of tonics and the iodides internally may be tried, but later on an operation should not be delayed. The operation should be performed under the most perfect hæmostatic and aseptic conditions. In very large tumours, the testicles, and the penis occasionally have to be sacrificed. The tumour must be emptied of blood as far as is possible by prolonged elevation above the level of the patient's body, and means taken for arresting hæmorrhage during the operation, either by clamps, elastic tourniquets, ligatures, either with or without preliminary transfixion with stout needles or skewers long enough to pass through the base of the tumour. Ballingall successfully removed an enormous tumour weighing 106½ pounds by transfixing the neck of the tumour in the middle line, the knife emerging at the perineum, and then passing through the opening a strong double ligature, which was brought up round each side and tightened by means of tourniquets. M'Leod advises that an elastic tourniquet about three feet long be taken, and the centre of it passed round the loins; the ends are brought over the brim of the pelvis, are crossed twice over opposite sides of the neck of the tumour, and finally are brought together below the navel. The neck of the tumour will thus be tightly embraced by two turns of the cord on each side crossing each other on the pubes, and just in front of the anus. No portion of diseased tissue must be left behind. Even although the prepuce appears to be healthy, it should be taken away close to the corona, and the raphé of the perineum should be removed to the verge of the anus. If any attempt is made to cover the penis or testes with flaps, these should be taken from the skin of the abdomen or thighs, and not from the neck of the tumour; but a satisfactory result can be secured without resort to flaps, which are prone to slough and suppurate.

The first step in the radical operation consists in decorticating the penis. The prepuce is slit up, and the skin incision continued from this slit along the whole dorsum of the organ to the root. The body of the penis is then freed by

finger and knife, the mucous membrane of the prepuce being carefully detached at the line of its reflection. The isolation of the penis is completed as far as its suspensory ligament, which should not be injured. A vertical incision is now made from the pubes to the fundus of the tumour, over one cord and testis. By successive bold strokes these are exposed, and then dissected out by fingers and knife, and subsequently held out of the way by an assistant. The other testis is similarly dealt with. The three vertical incisions are then connected at their pubic terminations by two transverse cuts, which must be beyond the limit of diseased tissue.

A circular or oval incision is now made round the rest of the circumference of the neck of the tumour, and by rapid strokes the whole mass is removed. Vessels are now looked for and tied; the largest will be found in the centre of the perineum and on each side of the pubes. By gradually loosening the cord others will be observed to spurt, and as many as 30 or 40 ligatures may be required. The parts may now be trimmed if any diseased tissue has been left behind. The testes may now be stitched together and fastened in proper position with catgut sutures. Pockets can easily be made for their reception by separating the deep layer of the superficial perineal fasciæ from the subjacent fat and areolar tissue. The skin can then be drawn over them from each side to a considerable extent by means of continuous catgut suture. The prevention of infection in such an extensive wound is difficult. The wound heals by granulation, and the process of repair occupies from six weeks to two months. Care must be taken to keep the penis free, as it is apt to become embedded in the mass of granulation tissue. The ultimate result of operation in the great majority of cases is satisfactory. Skin is dragged by the process of cicatrisation from the thigh to form a seamless substitute for the scrotum, and the penis acquires a fresh covering of epidermis. The sexual functions are restored, and both health and comfort re-established. If the skin of the penis is quite healthy, the scrotum may be removed alone by a circular incision round its neck, the testes being dissected out as the incision is deepened.

Lymph Scrotum ("Varix Lymphaticus").—This affection appears to depend upon a varicose condition of the lymphatics. The scrotum is noticed to enlarge and become peculiarly corrugated, studded with soft tubercles, which discharge from time to time a mixture of lymph and chylous fluids. The urine is often simultaneously chylous, and in some cases tumefaction of the inguinal glands has alternated with the appearance of chyle in the urine. Fever attends these paroxysmal attacks. This condition is allied to elephantiasis scroti, and is probably dependent on the same causes. The treatment consists in excision.

Diseases of the Testicle and Cord

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Anatomy of the Testis.—The testes are supported each in a separate pouch of the scrotum by its own spermatic cord.

Each testis is closely invested by a serous sac or tunica vaginalis, which consists of two layers —an inner or visceral closely incorporated with the testis and epididymis; and an outer or parietal which lines the corresponding cavity of the scrotum. The testis is supplied with blood by the spermatic artery; the vas deferens receiving a special artery, the differential artery, a branch of the superior or inferior vesical arteries. The spermatic veins commence in the testis and epididymis, form the pampiniform plexus in the cord, enter the abdomen through the inguinal canal, and open, the right into the inferior vena cava, and the left into the left renal vein. The lymphatics of the testis terminate in the lumbar lymphatic glands which encircle the large blood-vessels in front

of the vertebral column. The nerves are derived from the sympathetic system.

The testicles hang obliquely and at unequal heights in the scrotum—the left being the lower. They are of ovoid form, and measure $1\frac{1}{2}$ inches in length, nearly 1 inch in width, and $1\frac{1}{4}$ inches in thickness. The weight of each varies from $\frac{3}{4}$ to 1 ounce. With the exception of the posterior border, where the vessels and nerves enter or pass out, they are closely invested by the tunica vaginalis. Attached to the posterior border of the gland is the epididymis, principally composed of a long, tortuous efferent canal. Its upper extremity, larger than the lower, projects forward on the upper end of the testis, and is named the head, or globus major; the lower extremity is called the tail, or globus minor; whilst the intervening portion is the body. The epididymis, partly surrounded by the tunica vaginalis, is attached to the testis by fibrous tissue, and at the globus major also by the efferent ducts of the testis. At the front of the globus major and towards its outer side are found one or more small pedunculated bodies—the hydatids of Morgagni. They consist of connective tissue and blood-vessels, and are remains of the Müllerian duct.

The testis is enclosed in a dense, unyielding fibrous capsule—the tunica albuginea—which is prolonged at its posterior border for a short distance into the substance of the gland to form the corpus Highmori, or mediastinum testis. The mediastinum extends from the upper nearly to the lower end of the gland, and from its front and sides numerous slender fibrous cords and imperfect septa of connective tissue are given off in radiating directions to be attached to the internal surface of the tunica albuginea at different points, thus incompletely dividing the glandular substance into lobules. The whole inner surface of the tunica albuginea is covered by a multitude of fine blood-vessels—branches of the spermatic artery—tunica vasculosa. The gland substance is a mass of convoluted seminiferous tubules, loosely connected together by a peculiar fibrous tissue rich in lymphatic spaces. The diameter of these tubes is about 2 mm., their length about 60 cm., and their number between 800 and 900. Their walls are composed of several layers of flattened cells. Amongst the epithelial cells of the innermost layer several filaments or spermatozoa may be observed in different stages of development. As the seminiferous tubes approach the mediastinum testis they unite with one another at acute angles into a smaller number of tubes which have a less flexuous course, and at length become nearly straight. Close to the mediastinum they taper into short, straight tubes (tubuli recti) of smaller diameter and lined by flattened epithelium. The tubuli recti open into a network of vessels, which lies in front of the mediastinum—rete vasculosum testis—which have no proper walls, but are mere channels in the fibrous stroma lined by flattened epithelium. From this network originate twelve to twenty tubules—vasa efferentia—which perforate the tunica albuginea beneath the globus major, and having again become convoluted—coni vasculosi—they ultimately terminate in the convoluted canal of the epididymis.

The canal of the epididymis is disposed in numerous coils, and extends from the globus major downwards to the globus minor, where, turning upwards, it is continued on as the vas deferens. When unravelled it is 20 feet or more in length, with a varying diameter of from ·4 to ·27 mm., and is lined in its upper part by ciliated epithelium. The vas deferens forms the continuation onward of the epididymal canal. It ascends upon the inner side of the epididymis along the back of the testis, and passes upwards in the spermatic cord as far as the internal abdominal ring, where it turns suddenly downwards and inwards into the pelvis, crossing over the external iliac vessels, and turning round the outer side of the epigastric artery. Running beneath the peritoneum it reaches the side of the bladder, upon which it descends, curving downwards and backwards to the under surface of that viscus, and finally passes forward to the base of the prostate gland. In its course within the pelvis it crosses over the cord of the obliterated hypogastric artery and lies to the inner side of the ureter, beyond which it is attached to the coats of the bladder, in contact with the rectum. Gradually approaching its fellow of the opposite side upon the base of the bladder, it passes between the seminal vesicles—the duct from which it joins close to the base of the prostate—to form one of the common seminal or ejaculatory ducts. The vas deferens is about 18 inches in length, and has an average diameter of 2·5 mm. with a lumen of ·7 mm. Towards its termination beneath the bladder it becomes enlarged and sacculated, forming the ampulla of Henlé, and resembling in shape and structure a part of the seminal vesicle. Its walls consist of an outer areolar investment, an intermediate thick muscular layer, and a lining of columnar epithelium—not ciliated. From near the commencement of the vas or lower part of the epididymis a long narrow tube leads off, and becoming tortuous and convoluted, is rolled up into an elongated mass among the vessels of the cord—the vas aberrans. It is developed from the Wolffian duct of the fœtus. In front of the cord immediately above the head of the epididymis is a small body consisting of several small angular masses containing convoluted tubes lined with ciliated epithelium. It is sometimes called the paradidymis, and is a remnant of part of the Wolffian body.

The spermatic cord is formed by the vessels, nerves, and lymphatics of the testis, by the

excretory duct of the testis—the vas deferens—with its vessels and nerves, and by the coverings of these structures brought down from the several layers of the abdominal wall by the descent of the testis, with their vessels, nerves, and lymphatics. The vas deferens lies at the posterior aspect of the cord, and is to be easily recognised by its whipcord-like density when rolled between the thumb and finger. A considerable amount of connective tissue surrounds the vas and the blood-vessels of the cord. Three arteries occupy the cord: the spermatic, from the aorta, lies in front of the vas; the deferential, from the superior or inferior vesical, lies by the side of the vas; the cremasteric artery, from the deep epigastric, lies among the superficial layers of the cord and in its outer segment. The veins of the cord are divided roughly into two sets. The anterior and by far the larger set runs with the spermatic artery, is bound together by a good deal of connective tissue, and forms the pampiniform plexus. The posterior set is small and surrounds the vas deferens, running with the deferential artery. A few isolated veins, independent of these sets, are found among the tissues of the cord. The veins of the left side are larger than those of the right. The coverings of the cord are continuous above with the layers of the abdominal parietes and below with those of the scrotum. They are arranged from without inwards in the following order—intercolumnar fascia derived from the external oblique muscle, cremasteric fascia from the internal oblique, and infundibuliform fascia from the fascia transversalis.

Development of the Testicle and its Ducts.—It is almost superfluous to state that the testes of man are not developed in the scrotum, but in the posterior wall of the abdominal cavity. They lie at first behind the peritoneum, close to the kidneys, and may have a mesentery developed, known as the mesorchium.

To understand aright the vestigial structures associated with the development of the testicle, it must be borne in mind, in accordance with the law, that in development we have repeated the steps of evolution. The appearance of the kidney of human anatomy—the metanephros—is preceded by that of two other excretory organs—the pronephros and mesonephros—now only functional in fishes and amphibians. The pronephros, the most primitive of the three, is situated in the cervical region of the embryo. It consists of transversely running tubules opening at one end into the cœlom, and at the other into a longitudinal duct closed anteriorly, but which opens into the cloaca posteriorly, and is known as the Wolffian duct. The pronephros is believed entirely to disappear, the adjacent part of the Wolffian duct being accountable for the "stalked hydatid." The mesonephros, which appears as the pronephros passes away, is situated in the dorsal and lumbar regions, and consists of transversely running tubules opening at one end into the Wolffian duct, and having glomeruli developed at the other. The tubules may be conveniently divided into superior, middle, and inferior sets.

The superior tubules—as the cœlomic epithelium covering the inner side of the mesonephros becomes thickened and developed into the genital gland—acquire an attachment to the latter, and, losing their erstwhile urinary function, form the vasa efferentia and coni vasculosi of human anatomy. The middle tubules, retaining their connection with the Wolffian duct, which has now become the canal of the epididymis and the vas deferens, form the vasa aberrentia. The inferior tubules, losing their connection with the Wolffian duct, form the paradidymis or organ of Giraldés.

The other structures requiring mention are the Müllerian ducts, which are longitudinal ducts developed later than the Wolffian ducts, and ventral to them in position. Anteriorly these ducts open separately in the cœlom; posteriorly they unite and open into the cloaca; from their anterior extremities we have formed the "sessile hydatid," from the posterior the sinus pocularis; the intermediate portion disappears.

Descent of the Testis.—The passage of the testis from the abdominal cavity to the scrotum takes place at about the end of the eighth month of intra-uterine life. The gubernaculum testis is the active agent in bringing about the descent of the testis. This is a band of involuntary muscle fibres which traverses the inguinal canal, and establishes important connections both within and without the abdominal cavity. Below these main attachments of the gubernaculum may be recognised, viz.: (*a*) to the abdominal wall; (*b*) to the pubes; (*c*) to the bottom of the scrotum. Above the gubernacular fibres are chiefly connected with the testis; but many of them are also attached to the peritoneum in the posterior wall of the abdomen. By the traction which the gubernaculum exerts on the testicle the descent of that organ is brought about. By the portion attached to the abdominal wall the testicle is pulled down to the internal abdominal ring, the pubic portion drags it through the inguinal canal, whilst the central part finally leads it into the scrotum.

The formation of the processus vaginalis is accounted for in the same way. Some of these gubernacular fibres which are inserted into the peritoneum drag down the peritoneal diverticulum which lines the inguinal canal and scrotum, and prepares the way for the testicle. The processus vaginalis normally closes first at its upper end, then at its lower, and finally in the intervening portion.

Abnormalities of the Testicles.—Either

the testicle as a whole, including the epididymis, and more or less of the vas deferens, may be absent; or the testicle proper may be absent, the epididymis and the rest of the parts being present; or the epididymis and the vas may be absent, and the testicle proper may be present.

Supernumerary Testicles.—No well-authenticated example of a supernumerary testicle (polyorchism) is on record, but a few cases of absence of one (monorchism) or of both testicles (anorchism) have been reported.

Malposition of the Testicle.—One or both testes may be absent from the scrotum at birth, but may descend during the first few weeks or months of life, or even as late as the period of puberty. Late descent is usually accompanied by hernia. Malposition may be considered under the heads of incomplete descent or retention, and abnormal descent or ectopia.

Retention of Testis.—The testis may be retained in the following situations: on the posterior wall of the abdomen in relation with the kidney, in the cavity of the abdomen, partly within the internal ring, in the inguinal canal, or just outside the external ring. It is interesting to note that although the testis may be retained in the inguinal canal the tunica vaginalis reaches to a lower level, often as far as the bottom of the scrotum.

An incompletely descended testis is always small and undeveloped, usually atrophied and the seat of fibrous and fatty degeneration. Spermatozoa are almost always absent from such testes, their ducts, and the corresponding seminal vesicle. Curling held that all incompletely descended testes were sterile; and, while this is true of the vast majority, there are a few well-authenticated cases of fertile cryptorchids now on record who had all the signs of virility and were capable of sexual intercourse.

The diagnosis of retained testis is made by the absence of the testis from the scrotum, and the presence of the peculiarly sensitive swelling in the groin or elsewhere. The diagnosis is sometimes complicated by the coexistence of hernia.

The treatment depends on the age of the patient, the position of the organ, and the presence of complications. A young child with a comparatively well-formed testis lying just outside the external ring, or which may be easily pushed there out of the inguinal canal, may be fitted with a truss, furnished with a horseshoe-shaped ivory pad, applied above the level of the testis, and exercising a gentle pressure downwards and inwards towards the scrotum. This has usually to be worn for several years before descent is complete. If the testis cannot be brought out through the external ring it may either be left alone or castration may be recommended. If a hernia is associated, operation is indicated for the purpose of curing the hernia, and of removing the testis in the majority of cases. I have operated on many such, and have in nearly every instance found it necessary to sacrifice the testicle.

Ectopia Testis.—The testis is met with in three abnormal positions. The rarest of all (peno-pubic) is where the testis is situated in front of the pubes at the root of the penis. In the most common, the organ having left the peritoneal cavity traverses the inguinal canal, and then, instead of going on into the scrotum, travels into the perineum (ectopia perinealis). In the third form the testis leaves the peritoneal cavity by the femoral ring, and remains by the saphenous opening (ectopia femoralis). In the perineal form the gland may lie in the fold between the scrotum and the thigh, or more particularly in front and to the side of the anus, usually to the left side. It lies beneath the superficial fascia, and is surrounded by its tunica vaginalis. A testis so misplaced will be exposed to injury, and calls, therefore, for treatment during the second year of life. If the scrotum is developed on the same side it is usually not difficult to replace the testicle within it. An incision is made over the testis and, enveloped in its tunica vaginalis, it is freed from its surrounding attachments, the spermatic cord being carefully preserved and dissected free up to the external ring. A second opening is made in the bottom of the scrotum, and a pair of sinus forceps thrust upwards therefrom and made to emerge through the former opening; their blades are now widely separated so as to make a space in the scrotum for the reception of the testicle, which is then caught at its lower end by the forceps and pulled into its new home, where it is anchored by one or two catgut sutures to the edges of the scrotal incision. The scrotum may with advantage finally be fixed with a temporary suture to the skin of the thigh. In suturing the perineal wound it is well to arrange the sutures so as to at once close the track along which the testis has been drawn. I have twice operated successfully in this manner. If the scrotum is undeveloped, or the patient over puberty, castration is to be advised. In the femoral form the testicle cannot be transferred to the scrotum, because the spermatic cord traverses the femoral canal, and it is better, therefore, to remove it altogether.

Misplaced testes are liable to the ordinary testicular affections, and owing to their positions are under such circumstances much more serious sources of danger. Inflammation of such an organ may extend to the peritoneum and prove fatal. Abnormal position of the testis undoubtedly predisposes it to malignant disease, and should always be kept in mind where such abnormality is known to exist. In case of even suspected enlargement, therefore, immediate removal is at once called for.

Strangulated hernia in the sac of a testis retained anywhere in the inguinal canal is among

the most serious of the hernial conditions. It may occur at any age, its symptoms are always acute, strangulation is severe, and early operation is called for; the anatomical arrangements of the parts is often puzzling, and the satisfactory completion of the operation by radical cure of the hernia and removal of the testis if necessary is not always easy. It usually happens in these cases that instead of the hernia passing down into the scrotum, it turns upwards on emerging from the external abdominal ring, ascending upon the aponeurosis of the external oblique muscle, appearing in the groin as a superficial tumour reaching outwards from the external abdominal ring towards the anterior superior iliac spine.

Misplaced testis may be complicated with any of the varieties of hydrocele, and may be relieved by puncture or cured by removal or castration.

Abnormal Position of the Testis in the Scrotum.—The testicle is occasionally anteverted, *i.e.* the posterior and attached border becomes anterior, so that if a hydrocele occurs the testis is situated in front, and the tunica vaginalis behind and below. The testis is also sometimes, though very rarely, inverted, *i.e.* its upper end is below, so that the vas deferens starts from an epididymis, the tail of which is above the testis.

Hypertrophy and Atrophy of the Testicle.—*Hypertrophy* may occur when the other testis has become atrophied, or has failed to be developed, or after removal of the opposite testicle. In some cases in which one testis has been retained within the abdomen, or has been absent altogether, the other testicle has been more than double the normal size and weight.

Atrophy of the testicle may be congenital, or may be due to arrested development; it occurs also from the prolonged administration of the iodides. It is usually seen, however, in one of two forms—the results of different vital processes: (1) In those cases which are due to inflammation, whether traumatic, syphilitic, or otherwise, there is a marked shrinking and sclerosis of the testis; all the connective tissue of the gland is increased and shrunken, and by its compressing effects the secreting structure is destroyed. The gland shrivels to the size of a horse-bean, or even less, is hard and nodular, and on section shows nothing but bands of connective tissue, with here and there a few scattered seminal tubules. (2) The other form of atrophy is much rarer, and results from the cutting off of the arterial supply, or from nerve lesions, and not from inflammation. It is of the nature of a fatty degeneration of the glandular structure unaccompanied by any sclerosis of the connective tissue. The testicle in this form of atrophy becomes much reduced in size, but is soft and flabby instead of being hard and nodular. A section of the gland is anæmic, and fatty tissue may also be found beneath the visceral tunica vaginalis between the epididymis and back of the testis. The atrophy associated with varicocele, hydrocele, or due to truss pressure is of this kind. In both forms the epididymis shares in the atrophy. Arrest of development is to be distinguished from atrophy of a once well-formed organ. This arrest is commonly found in undescended and ectopic testes. The common sequelæ of atrophy of the testis are neuralgic pains and sterility. Treatment of atrophy can only be preventive; the cause should be removed when possible.

Injuries of the Testicle.—With the exception of contusion, traumatic lesions of the testis are rare, owing to its firmness and its slipperiness in its scrotal bed.

Punctured Wounds.—These are almost always of surgical origin, their most frequent cause being puncture with a trocar and cannula in tapping for hydrocele. A very acute pain is felt, in some cases inducing syncope, and the escape of a little blood through the cannula as soon as the trocar is withdrawn, and then of blood-stained hydrocele fluid as soon as the end of the cannula is withdrawn from the tunica albuginea, and has come back into the vaginal sac, are the indications of this accident. The consequences of such an accident are orchitis and hæmatocele. Suppuration and gangrene have followed, but they are rather the result of infected instruments, and are sometimes seen without the testicle being wounded.

Incised Wounds.—These are rare, and if superficial heal quite readily, but if the wound deeply involves any considerable length of the organ, it may subsequently atrophy, as all the tubular structures on the distal side of the wound become functionally useless, and the contraction of the cicatricial material unduly compresses the gland. Hernia of healthy testis tissue is said not to occur after clean cut wounds.

Contused Wounds.—These are the most frequent of the traumatic lesions of the testicle. They are caused by blows, falls astride, kicks, squeezes, and other forms of violent pressure.

Symptoms.—The pain of such injuries is acute and unsupportable, and is often severe enough to produce syncope. It radiates to the thigh and extends along the cord, often to the loin. Death from shock even may be the result of contused wound of the testicle, occurring sometimes instantaneously, but more often perhaps after the lapse of several hours.

Prognosis.—The immediate result of such injuries as a rule is good; but subsequently permanent atrophy often occurs. Chronic orchitis is occasionally seen, and encysted hydroceles of the epididymis and of the testicle itself may be met with at a later period. The diagnosis of these several injuries is simple enough, and their treatment is conducted on the ordinary lines of surgical practice.

Dislocation of the testis, as distinguished from congenital displacement, is in rare instances produced by traumatic or other injury, the organ being forced from its proper site into the perineum, the femoral, or the inguinal regions.

In traumatic *displacement* immediate reduction must be effected, by manipulation if possible, and this failing an open operation must be made. If reduction cannot be accomplished, castration is probably the best procedure to adopt.

Torsion, or Axial Rotation of the Spermatic Cord.—This is a remarkable accident, in which the testis becomes strangulated owing to twisting of the spermatic cord and consequent chokage of the spermatic blood-vessels. It may occur in a testis lying normally in the scrotum, but is more often seen in an undescended or partially descended organ. It is met with at all ages, but is most common in young adults, and can only occur when the testicle is freely suspended in the tunica vaginalis. The spermatic cord becomes twisted upon its axis, usually in a lævo-rotatory direction, and gorged with blood. The testis or epididymis, or both, may be acutely inflamed or even gangrenous, and atrophy may follow. The symptoms are like those of strangulated hernia or inflammation of the testis and epididymis, for either of which the condition has usually been mistaken: a painful swelling suddenly appears in the groin or scrotum, dull on percussion, tense, tender, irreducible, and without impulse. Pyrexia is usually present, and sickness is a constant symptom.

Morris says a diagnosis can be made by (1) the empty condition of the inguinal canal; (2) the unobscured cord; (3) the imperfectly descended testis; (4) the absence of the testis on one side of the scrotum; (5) by the epididymis being in front of the testis; and (6) by the existence of a lump or knot on the cord with swelling between the knot and the testis, and the natural state of the vas deferens above the knot.

Treatment.—The only effective treatment is by early operation; the cord being untwisted if the testes appear to be in a recoverable condition. A retained testis, or one which is much swollen and discoloured, is best removed.

Hæmatocele in the Scrotum.—This consists in an effusion of blood into a pre-existing cavity, either the cavity of the tunica vaginalis or into a cyst of the cord. By far the larger number are into the tunica. Extravasation of blood into the connective tissue of the spermatic cord or scrotum, or into the substance of the testis, are simple hæmatomas, and differ in no way from similar effusions in other parts of the body.

Hæmatocele of the Tunica Vaginalis.—Spontaneous hæmorrhages into the tunica vaginalis are occasionally seen, but as a rule such effusions are traumatic, and are the result of contusions or of punctured wounds. They most often occur after tapping a hydrocele, and may be occasioned by the puncture of a vessel in the scrotal wall, the epididymis, or the testicle. The nature of the accident may sometimes be recognised by the escape of blood which takes place from the cannula in the withdrawal of the trocar; but more often no outward symptom is noticed at the time, the side of the scrotum which corresponded to the hydrocele being found to become larger within an interval which may range from hours to days according to the rate at which the blood escapes. Bleeding may occasionally follow from weakened and varicose vessels of the tunica vaginalis in the withdrawal of the fluid which had given these weakened vessels support. Vaginal hæmatocele is occasionally seen where no hydrocele has been present.

Pathological changes in hæmatoceles vary with the age of the effusion. In old cases the sac is greatly thickened, partly by layers of fibrinous membrane or connective tissue, and partly by sclerosis of its own structure. Both the false membrane and the closed sac may be in places cartilaginous or calcareous. The tissues outside the sac are thickened; and the testis, usually healthy, sometimes atrophied and occasionally scarcely recognisable, lies usually at the posterior and lower part of the hæmatocele. The contents of an old hæmatocele are chiefly solid, and consist either of dirty brown coloured clot, laminated as in an aneurysm, or of soft clot devoid of lamination. The fluid blood, if any be present, will be thick, dark, and treacly. In more recent cases cholesterine may be found, the sac is much less changed, and the fibrinous laminæ are but feebly adherent; the contents are a mixture of deep red fluid blood and dark blood-clot partly adherent to the walls.

Symptoms.—The formation of a globular or pyriform *heavy*, opaque swelling in the scrotum, either rapidly or insidiously, after a contusion or puncture, with much ecchymosis of the skin and an absence of acute inflammatory signs, is easy to understand. The tumour is elastic or doughy, not very tender on handling; pain is dull and aching. Testicular sensation is at first unaffected, and may be found behind the tumour. Acute hæmatoceles have to be diagnosed from hernia, hydrocele, and orchitis; and old hæmatoceles from malignant growths. As a rule the diagnosis can be made, but when doubt is felt the tumour should be dealt with in the first instance by aseptic exploration and then treated according to the condition present.

Treatment.—Treatment may be either palliative or curative. Palliative is applicable in the early stage, and consists of horizontal rest, with the scrotum well raised on a cushion, or in a sling; the constant application of an ice-bag in the robust, and of evaporating lotions

in the old or feeble. If little or no progress in absorption is made within one or two weeks, some of the fluid may be withdrawn through a cannula; and repeated if necessary. When pain and marked tenderness are absent, strapping may be applied with advantage. For radical relief the best treatment is free incision into the sac, and after turning out the contents the *parietal layer* of the tunica vaginalis and any adherent false membrane should be removed as far as possible. A suppurating hæmatocele must be treated by free incision, thorough clearing out, and gauze drainage. Castration should be performed when the testis is useless; when the tunica vaginalis is thickened or hardened by disease; when the patient is old and feeble; when much blood is also diffused among the tissues of the scrotum, or when sloughing is threatened. Castration shortens convalescence and diminishes the risk of hæmorrhage, of cellulitis, and of septicæmia.

Hæmatocele of the Cord is rare, and consists in an effusion into an unobliterated part of the funicular process. A history of injury would give the clue to the nature of a rapidly forming, opaque, circumscribed, tense, mobile swelling in the inguinal canal of a non-inflammatory origin. Should operative treatment be called for, a careful aseptic enucleation of the tumour must be performed.

Hæmatoma into the substance of the testis is sometimes described as "hæmatocele of the testicle." Its treatment is that of hæmatoma elsewhere.

Hæmatoma of the Cord.—Hæmatoma of the of cord is but rarely seen. It is due to the rupture of one of its vessels as a result of injury or strain. A swelling of considerable size rapidly forms, extending along the cord from the inguinal region to the scrotum; the testis remains free and unimplicated. Such a condition is very likely to be mistaken for an omental hernia, but on careful examination the tumour will be felt to be more uniform in consistency, more rounded in outline, and even semi-fluctuating. It is always irreducible. The history of injury will give a clue to correct diagnosis.

Treatment in the early stage consists in the application of elastic pressure or evaporating lotions, and later on, if the effusion is not absorbed, it may be relieved by aseptic tapping if the contents are fluid, or if threatening to inflame, the cavity must be laid open and the coagulum removed.

Varicocele.—This affection consists of a varicose enlargement of the veins of the pampiniform plexus and lower part of the cord. Including the mild degrees of the disorder, it is one of the commonest affections of the male genitals. In severe cases of varicocele all the veins of the cord may be involved.

The veins of the pampiniform plexus are dilated, tortuous, much increased in size and in number, owing to dilatation of many smaller vessels forming flexuous curves and loops. The elasticity and contractility of the coats of the veins are diminished in advanced cases, and the coats are also somewhat thickened. Thrombosis and phlebolithes are frequently present. The degree of enlargement varies much, and may occasionally be so great as to fill the scrotum and conceal the gland. It rarely extends as far as the inguinal canal. The testis is, as a rule, both well developed and functionally perfect, but in a small number of old-standing cases it may become atrophied to some extent and even occasionally functionless. Varicocele is to a great extent due to the following anatomical factors: the size and winding course of the spermatic veins; their numerous anastomoses; the loose, inelastic tissue in which they lie; their passage through the oblique inguinal canal; and the length and comparatively small size of their efferent trunks. The left side is more often affected than the right, because of the lower position of the left testicle; the point of entrance of its vein into the left renal veins is at a higher level than that of the right into the vena cava; the left enters the renal at a right angle, and the right enters the cava obliquely; the left passes beneath the sigmoid flexure. Varicocele is more apt to develop in the weak and flabby than the strong and robust. It usually commences between the fifteenth and twenty-fifth year, developing for about twelve months, and tending to disappear after marriage and as men grow older. Apart from or perhaps in connection with the above-mentioned anatomical causes, varicocele may be caused by constipation, sedentary habits, masturbation, ungratified sexual passion, tight belts about the abdomen, and the pressure of trusses.

Symptoms.—The testicle is usually normal, though it may be smaller; the scrotum is more or less relaxed, and occasionally varicose veins are seen on its surface; the veins swell up and form a distinct swelling thicker below than above, feeling like a bag of worms, and disappearing in the recumbent position. The blue colour is often visible through the thin skin. There is usually an impulse on coughing. The pressure of a finger on the external abdominal ring increases fulness and distension. As a rule, varicoceles are painless; but in weak, neurotic men aching is complained of in testis, cord, groin, and loins, and also a sense of weight and dragging. Severe spasmodic pain is sometimes felt. In some cases varicocele gives rise to severe mental despondency and a dread of impaired virility. Long standing, riding, and walking, or sudden exertion aggravate the swelling, and greater discomfort is therefore often felt towards evening.

Treatment.—Treatment may be either palliative or operative. Palliative treatment will

suffice for the relief of a large majority of cases, and "must be directed to the patient's mind as well as to his body." The surgeon must assure his patient that there is no risk of impairment of virility, and that no operation is required. Occupation for the mind and body should be found, attention paid to general health, constipation avoided, cold or chilled morning baths should be taken, with local bathing of the genitals night and morning in cold water. A well-fitting suspensory bandage should be worn regularly, and such patients should be allowed to marry.

In certain cases, however, operation is justifiable; they are as follows:—steady increase in size in spite of treatment, and when accompanied by distress and pain; exclusion from one of the public services; increasing atrophy of the testis, and where frequent seminal emissions are giving rise to much mental distress.

Many operations for the radical cure of varicocele have been devised. The older methods by gradual obliteration, etc., and the various subcutaneous procedures, have been quite superseded by the safer, simpler, and more certain methods of excision. One of two operations is generally performed at the present time, which differ from each other only in the extent to which the structures of the cord are removed; in one the varicose veins alone being taken away, and in the other the whole thickness of the cord, except the vas and its attendant artery and veins, is removed, and the cord thereby permanently shortened.

The operation of excision is performed in the following manner:—The hair having been previously shaved from the parts and the skin made clean, the surgeon stands on the side to be operated on, and pinches up the cord at the uppermost part of *the scrotum* between his left thumb and forefinger in such manner as to stretch tightly the overlying skin. A longitudinal incision, half to three-quarters of an inch long, is made through the tense skin, and is deepened gradually until a little pellet of fat or a loop of varicose vein pushes itself into the wound. No further cutting is required, as nearly the whole length of the cord can be pulled out in the form of a loop through this small opening; its several parts may be easily recognised, and may be dealt with as required. If simple excision of the varicocele is to be performed, the veins are separately isolated, tied below and above with catgut ligature, and the intervening portions cut away; one or several vessels may be dealt with, and any length of them may be removed. Instead of taking away the veins only, the whole thickness of the cord—except the vas and its vessels, which can be both felt and seen posteriorly—may be isolated, tied first below, an inch or more above the testicle, and then above, at the highest level to which the cord can be pulled downwards, and all the intervening part—from two to five or six inches—cut across and removed. The end of each of the ligatures may be left long, that they may be tied together, so as to bring the divided ends of the cord into close proximity with each other, thus shortening the cord and raising the testis from its pendulous position nearer to its proper level. It is seldom any bleeding vessels have to be tied. The approximated ends of the cord are gently pushed back through the scrotal wound, which is closed with a single silk or horsehair suture. No drainage is required; the parts are dressed with dry aseptic wool, and are supported with a triangular bandage.

The patient should lie in bed for two weeks, and should wear a suspensory bandage afterwards for two or three months.

The operation is occasionally followed by some œdema of the scrotum, a little engorgement of the testis, and a moderate effusion into the tunica vaginalis; but true orchitis is rarely seen. Some thickening and tenderness is often left at the site of operation which is slow to disappear.

Bennett insists on the importance of not only excising the dilated veins, but of effecting at the same time the immediate permanent shortening of the elongated cord, by leaving the sheath of fascia which immediately surrounds the varicocele intact, and including it with the veins in the ligatures, the precise extent of a varicocele which it is desirable to resect being determined by the amount of elongation of the cord.

In the large majority of cases removal of the pampiniform plexus alone results in complete and permanent cure, and Bennett's operation, therefore, may well be preserved for the more severe cases.

Epididymitis is the term applied to inflammation of the epididymis, and may be acute, subacute, or chronic.

Acute and Subacute Epididymitis.—Acute or subacute epididymitis is almost always excited by some affection of the membranous or prostatic urethra, such as gonorrhœal, gouty, or other forms of urethritis, the passage of urethral instruments, impacted urethral calculi, urethral injections, and urethral or meatal strictures; by inflammatory and ulcerative conditions of the prostate and seminal vesicles, and by prostatic calculi. Injury rarely causes this affection; the inflammation is probably the result of direct extension of a pre-existing inflammatory process, and is neither due to metastasis, sympathy, nor reflex congestion. The globus minor is the part chiefly first affected. The thickening of the globus minor is due to inflammatory exudation immediately beneath the tunica vaginalis into the cellular tissue between the convolutions of the duct. The tubes of the epididymis are in places dilated into small pouches filled with pus. The

tunica vaginalis covering the epididymis is always somewhat inflamed.

Microscopically the interlobular tissue is the seat of round-cell infiltration. The blood-vessels are distended, and the lumen of the tubules is filled with desquamated cells, exudate, and leucocytes.

Symptoms.—Signs of inflammation affecting one side of the scrotum of a patient in whom any of the above causes are found to be present suggest at once the nature of the malady. Aching along the course of the cord and thickening of that structure are usually present. The shape of the swollen epididymis is characteristic—beginning below in the globus minor it rapidly increases until it forms a large crescentic cup-shaped mass behind and to the outer side of the testicle; later, effusion occurs into the tunica vaginalis and obscures the characteristic swelling, and the testis may become involved by extension of the inflammation through the hilum. The scrotum is more or less red and œdematous. Rigors may usher in the attack, and the general phenomena of fever are present. In acute cases the symptoms increase for four or five days, and remain at their height for two or three days more, when they rapidly decrease, and the patient convalesces two or three weeks afterwards. Some hardening of the globus minor may remain for months, or even become completely organised, and when this affection is bilateral, permanent sterility may follow. When epididymitis occurs in the course of urethritis, the urethral discharge generally ceases or diminishes during the acute stage of inflammation, and returns again when this has subsided. Though both sides may be affected, they are never affected simultaneously.

With few exceptions acute epididymitis terminates in resolution. A small hard thickening in the globus minor may persist for a long time. Suppuration is rarely met with. Sloughing has been seen, and in very rare cases a local or general peritonitis has been set up.

Treatment.—The treatment consists in keeping the patient in bed, with the scrotum supported on a small pillow, and an ice-bag constantly applied. Lotions of spirit, lead, and opium are serviceable, and glycerine of belladonna often gives great relief. The bowels must be cleared with calomel, and a simple saline mixture, containing one-twelfth of a grain of tartarated antimony, given if the inflammation runs high. Where pain continues under the application of local cold, warm fomentations—medicated or otherwise—may be substituted, and morphia suppositories may be employed. In strong individuals the application to the scrotum of eight or ten leeches is often followed by striking relief. The diet should be light and non-alcoholic. After the acuteness of the inflammation has subsided the organ remains large and somewhat tender, and should be carefully supported and gently compressed by a triangular bandage over several layers of absorbent wool. At the end of a fortnight, if all pain and tenderness have passed away, the testicle should be lightly strapped and the patient allowed up, the scrotum being supported in a well-fitting suspensory bandage or Baer's triangle.

Chronic epididymitis is usually tuberculous, and in rare cases syphilitic. It is treated under tuberculous and syphilitic diseases of the testicle. Localised chronic gouty nodules are seen occasionally in the epididymis, which may persist for months or years.

Inflammation of the Testicle (Orchitis).—Inflammation of the substance of the testicle itself is met with in the acute, subacute, and chronic varieties, and must not be confounded with the more common inflammation of the epididymis (epididymitis), to which it may be primary or secondary, and with which it often coexists.

Acute and Subacute Orchitis.—Acute inflammation of the testis is comparatively rare, owing to the presence of the firm, dense, unyielding tunica albuginea and the free mobility of the testicle itself.

It may be due to the following causes:—Injury, contusion or wound, cold, extreme and prolonged ungratified sexual excitement, mumps, gout, rheumatism, and certain specific febrile disorders, as influenza, smallpox, typhoid, scarlet fever, malaria, septicæmia, and pyæmia. It occurs also in leprosy and glanders.

Little is known from actual investigation of the pathology of acute orchitis, as the malady is not fatal in itself, and the surgical removal of the inflamed organ is not called for.

Acute and subacute orchitis may terminate by resolution, commonest of all; by suppuration, which is rare; by gangrene of the testis, which is still rarer; and by atrophy, which is not at all uncommon; or it may become chronic.

In every case of acute orchitis it is judicious to warn the patient or his friends that atrophy may follow, and may be permanent.

Symptoms of Acute and Subacute Orchitis.—Acute orchitis has to be distinguished from acute epididymitis, and the recognition is not difficult. The absence of pre-existing urethral trouble is suggestive. The shape of the swelling—if seen early—is smaller, rounder, and ovoid, as contrasted with the larger acorn cup-shape of an inflamed epididymis. The rapid onset, the previous history, and associated signs and symptoms elsewhere, make the diagnosis plain.

Gouty orchitis commonly affects men over fifty who are subjects of gouty arthritis, or other gouty lesions, and is commonly attended with the formation of a considerable amount of

fluid in the cavity of the tunica vaginalis; it is very prone to relapse, and is often, therefore, very tedious; it occurs in sudden seizures, and is sometimes transferred by metastasis from one testis to the other. It occasionally suppurates, and may extend to the epididymis.

Rheumatic orchitis appears chiefly to be an affection of the tunica albuginea. It comes on suddenly, with much tenderness and little tumefaction; often shifting from one testis to the other, and disappearing almost as suddenly as it comes on.

Mumps orchitis occurs in about 15 per cent of all cases of mumps in males, and is therefore by no means uncommon. It is usually met with at the period of puberty, and begins about the fifth of sixth day in one or both testicles. It reaches its height in four or five days, is extremely painful, and rarely suppurates. It usually resolves, sometimes becomes chronic, but often ends in rapid and complete atrophy, especially in cases which occur in epidemics.

Typhoid orchitis rarely, if ever, affects the epididymis, unless the inflammation is set going by catheterism, and then the epididymis alone may be attacked. The testis only is implicated. The onset is commonly gradual, but may be sudden; it occurs during the height of the fever, or during convalescence later on. The pain is not so great as in other forms of orchitis. The inflammation is not generally severe; the attack lasts from six to ten days; it usually ends in resolution, but suppuration, atrophy, or persistent induration occasionally follows.

Malarial orchitis follows or accompanies the fever, but generally at a late period of the disease, and yields readily to quinine. It comes suddenly, lasts two or three days, during which the testicle swells to three or four times its natural size, being blended with the epididymis in a hard, smooth mass. The scrotal veins swell, the skin is œdematous, and there is generally a little fluid poured out into the tunica vaginalis. Pain is severe, and may be paroxysmal, and passes off when the temperature falls. The swelling may take three or four weeks to disappear, and the testis may be left atrophied, and the epididymis enlarged and hard.

Treatment of Acute and Subacute Orchitis.— Treatment will vary somewhat with the cause of the inflammation. Ice locally, or iced lotions, are spoken highly of by Jacobson. Leeches, followed by warm belladonna or opium lotions, have been useful in my practice. Needle puncture of the inflamed gland has been strongly advised by Smith and Macnamara. Glycerine of belladonna often gives relief. Rest in bed, with the scrotum supported on a high pillow or in a "sling" is essential. Calomel purges and saline draughts, with small doses of tartrate of antimony, sometimes act like specifics. Constitutional conditions must be treated according to their nature. After a few days, when the painful symptoms have subsided, light strapping of the testis will shorten convalescence.

Chronic Orchitis.—Chronic inflammation of the testicle is usually of syphilitic origin. It occurs occasionally as an affection secondary to tubercular epididymitis, and sometimes follows an acute orchitis from injury. From its frequent association with syphilis, chronic orchitis may be considered under the heading of syphilitic affections of the testicle.

Infantile Orchitis. — Inflammation of the testicle may be met with in infants and young children. A subacute form occurs in children of a few months old, the testis being found somewhat enlarged and hard. It is probably the result of slight injury, and passes away under simple protective measures.

Syphilitic Affections of the Testicle.— *Syphilitic Sarcocele.*—The affections of the testis due to syphilis are acquired or congenital:—

Acquired. — Orchitis and epididymitis in secondary syphilis; gummatous and interstitial orchitis in tertiary syphilis.

Acquired Affections in Secondary Syphilis.— Although a matter of rare occurrence, there is no doubt that occasionally during the progress of serious secondary syphilitic symptoms the testicle becomes affected with a subacute form of inflammation. I have seen this form of orchitis several times. In the fifth or sixth month after the primary sore the testis becomes larger, hard, and tender, its surface irregular and "knobby," the knobs varying in size from a pea to a hazel-nut; the tenderness is not excessive, and little pain is complained of. The organ slowly increases in size for four or five weeks, and then gradually subsides, leaving the gland apparently in its normal state again. This condition is distinct from the more frequently seen syphilitic epididymitis, which comes on early in the secondary stage, is preceded by urethral discharge, and consists of a localised nodular mass in the globus major—the body of the testis remaining quite unaffected —and which also disappears entirely under the influence of mercury.

Gummatous Orchitis.—This, the more common form, may coexist with the above, or may appear at a later stage. It commences in a localised proliferation of the corpuscular elements of the intertubular connective tissue, which is quickly followed by fatty degeneration. The gummata are usually multiple, and in size varying from a pea to a walnut. They appear as somewhat elastic and yellowish white or grey knobs, are firm to the touch, owing to the intermingling of fibrous tissue with the fatty debris of which they consist, and are dry, owing to their slight vascularity. As in other visceral gummata, those of the testicle are surrounded at first by a vascular area, which later on is converted into a whitish fibrous capsule. Within this are

the usual broken down cell products, intimately mixed with incompletely fibrillated tissue, the central portion being composed almost entirely of fatty granular debris.

Gumma of the testis rarely suppurates, but in the majority of cases the morbid product is in part absorbed and in part becomes contracted. Destruction of the secretory portion of the gland is rarely avoided, and with it, and in proportion to its extent, occurs a diminution in the amount of semen secreted, or even total aspermia, or a decrease of sexual desire and impotence. At the end of many months the testicle is found diminished in size; its general shape may be preserved, the surface remaining smooth, or else we find depressions alternating with elevations. At times the organ is reduced to a shapeless nodular rudiment of a testicle.

Occasionally the gummatous infiltration forms a tumour of considerable size, and foci of softening are found in it; when this occurs all the coverings of the testis are generally also involved. Should these become perforated, the gumma will grow exuberantly fungus-like towards the surface, as a soft granular mass.

Diffuse Interstitial Orchitis.—This is simply a chronic interstitial inflammation of the intertubular connective tissue. The swelling originates with the appearance in the intertubular connective tissue of crowds of nuclei-like bodies or "indifferent cells." This early stage is followed by an overgrowth of young connective tissue, which gradually becomes more and more fibrous. When the whole testis is affected, owing to the lobular segmentation which is normal to the organ, the masses of fibrous tissue take a somewhat conical form, the base of each cone lying against the usually thickened tunica albuginea, while its apex is directed towards the mediastinum testis. By the pressure and contraction of the overgrowth of connective tissue the seminal tubes become separated from each other. Their walls are at first thickened, then their epithelium wastes, becomes fatty, and is detached. Occasionally, by the unequally distributed contraction of the new-formed connective tissue, some of the tubes are dilated into irregular gaping lacunæ-like spaces. Nothing is ultimately left of the testis save a hard resistant mass of fibrous tissue, with here and there fatty debris pointing to the relics of the seminal tubes. The epididymis and sac usually remain intact. The tunica vaginalis is also affected. At first more or less fluid occupies its sac, but later on this becomes absorbed, as the two serous surfaces, thickened and altered, begin to adhere at several spots until the whole cavity may be obliterated. The tunica albuginea, too, is also much thickened.

Congenital Syphilitic Disease of the Testicle.—This form of orchitis is usually of the interstitial variety, sometimes associated with gummata; but the pure gummatous form is rare. Both organs are often simultaneously attacked. The gland is hard and nodular, is not painful or tender, or large. It is often associated with hydrocele, and is prone to subsequent atrophy. Fungus testis has been recorded in a child of ten months old, and typical gummata have been seen in a boy of six years.

Symptoms of Syphilitic Testis.—As a rule the general health keeps good. If both testes are affected the interval since the primary disease will usually be found to have been short; but if only one be affected, it may have been of several years. Syphilitic affections of the testis are seldom seen either in the early secondary or the later tertiary stage. They belong distinctly to the intermediate group, occurring from two to four years after primary symptoms. It is important to remember that in this affection we occasionally meet with distinct masses of deposit in the epididymis. The most common condition, however, is a general enlargement of the whole gland, with a smooth rounded exterior. The size attained varies from that of a hen's egg to that of a small fist. The enlargement is slow in development, and usually painless. Abscesses may occur if no treatment is resorted to, and these may lead to fungus testis. The syphilitic testis sometimes attains a large size, and may then be known by its peculiarly rounded outline and light specific gravity A gumma feels decidedly lighter in the hand than either hæmatocele or malignant growth. The vas deferens is seldom thickened, and the gland is quite devoid of the ordinary testicular sense. The scrotum is unaffected except when hernia testis threatens, and there is often fluid in the tunica vaginalis.

One testicle only may be affected, or both may be so, either consecutively or simultaneously; the second testis may be attacked whilst the patient is under specific treatment. The function of the testis is lost if the disease is not successfully treated. Syphilitic orchitis may follow immediately upon an injury in a syphilitic subject.

Diagnosis.—Syphilitic orchitis has to be diagnosed from simple chronic orchitis, tubercular disease, and new growths—innocent and malignant.

Simple chronic orchitis occurs in the absence of syphilitic history; it is usually the result of injury; the swelling rarely attains a large size; testicular sensation is present, and the effects of antisyphilitic treatment are negative.

It is rarely difficult to distinguish between syphilitic and tubercular disease, at least in their early stages. The well-marked and easily recognised nodules in the epididymis in the latter cannot well be mistaken; but in those cases where a primary gumma forms in the epididymis it is often extremely difficult to distinguish between them, and the same terminations may await both, with the exception that

specific treatment generally shows marked effect in those cases which are due to syphilis. In cases in which the vas is enlarged, examinations should always be made as to the existence of stricture; but there are certain rare cases in which the vas and the epididymis are enlarged, and without any evidence of urethral disease. The vas behind the testis may become greatly thickened and convoluted without any tendency to abscess or any formation of gumma, and may so remain for months or even years together.

In a general way it is not in the least difficult to diagnose between syphilitic and malignant disease of the testes. In the latter the growth is rapid and steadily progressive, its rate of progress, indeed, always increasing with its size. There is almost always in some parts of it pseudo-fluctuation, and it is more or less nodulated. To the above symptoms we may add that the scrotum becomes adherent, and shows a dusky tint with enlargement of superficial veins; and, lastly, that the cord itself is often thickened. In all these features malignant tumours of the testis differ from what we find to be the usual condition of syphilitic disease. It is far more common to find both testes complicated at once in syphilis than in cancer, whilst the cord almost invariably remains free.

Treatment of Syphilitic Testis.—This should be both local and constitutional. The local consists of removing any hydrocele fluid by tapping, and then strapping the testicle with mercurial plaster. In the interstitial form mercury should always be carefully and perseveringly given, but where a gummatous affection is present, iodides of potassium, sodium, or ammonium are indicated. These are best given with spiritus ammon. aromat. and liquid extract of sarsaparilla, freely diluted with water, and taken by preference half an hour before food. The doses of iodides must be increased weekly until the swelling shows signs of lessening; should the drug disagree with an empty stomach it may sometimes be given immediately after food without inducing discomfort. Obstinate cases in elderly men, particularly if fungating, are often best dealt with by castration.

Tuberculosis of the Testis and Epididymis.—Primary or hæmatogenic tuberculosis is very rare in the testis, the disease almost always commencing in the epididymis, and spreading to the body of the testicle as a secondary process. This greater liability of the epididymis to tuberculous infection may be due to the fact, that in descending tuberculosis from the urinary tract the epididymis is first exposed to infection, but clinical experience points to the epididymis as the seat of primary trouble in about 50 per cent of urogenital tuberculosis. It is most common between 20 and 30 years of age, but may occur at any period between early infancy and advanced old age. The disease usually commences on one side, but the other is liable to become affected. Whether a previous gonorrhœal epididymitis is a predisponant is uncertain, but many cases occur without a past venereal history. The disorder usually commences as a small nodule in the globus major, followed at times by similar nodules in other parts of the epididymis. By degrees these nodules may coalesce until the whole epididymis is converted into an irregular, hard, boat-shaped swelling. At a later stage the tuberculous mass softens and breaks down in one or more places, and, after ulcerating through the tissues of the scrotum, it may heal and break down again, or a fistulous opening or a hernia testis may result. At the periphery of these young nodules younger grey miliary tubercles develop, and when the testis itself becomes involved its substance may be thickly studded throughout with them.

Tubercular disease extends from the epididymis along, thickening the cord, to the prostate, seminal vesicles, and bladder. It is important always to bear in mind that tuberculous disease often begins in the prostate or seminal vesicles, and in every case of testicular tubercle, therefore, these structures should be carefully examined. The progress of the affection may be rapid or slow, just as we see in tuberculous joint diseases, and may terminate at any stage by complete resolution or complete destruction.

It has been much disputed whether the exact starting-point of tuberculous disease of the testis is in the tubes or in the connective tissue of the organ, but it is probable that the process starts in the walls themselves of the seminal tubes—usually in those of the epididymis first. At certain circumscribed spots the connective tissue of the tubes proliferates, and thus becomes infiltrated with masses of round cells, which tend to break down and become caseous. Nearer the interior of the tube the epithelial cells become swollen and fused together into irregular foci, which become detached into the lumen of the tubes, and fusing with the caseous products which are produced by the cell proliferation of the masses in the walls of the tubes, the characteristic white nodules are produced. The vitality of the immediately surrounding tissues being much impaired, inflammation is set up around these masses, and thus the neighbouring intertubular tissue, which is also infiltrated in the round cells, becomes invaded, and takes a share in the formation of caseous nodules. Usually the nodules increase in size, and then fuse to form larger masses, which break down into cavities containing pus and form fistulous openings. More rarely the process is arrested, the masses becoming encapsulated as in the lung by an interstitial inflammation.

Symptoms and Diagnosis.—Tuberculosis of the testis and epididymis is often a very

insidious disease, and is overlooked by the patient for a long time. It sometimes appears as if it originated in an acute inflammatory attack, but the symptoms as a rule are so characteristic of the affection that the diagnosis is not difficult. Even in the early stage the insidious formation of a small painless nodule in the tail or head of the epididymis, to which the patient's attention may be only drawn accidentally is enough to at once excite a suspicion of commencing tuberculous disease. A little later another enlargement is noticed at another part of the epididymis. These little nodules gradually run together, and form an irregular nodulated mass, which, of somewhat crescentic shape, surrounds the testis at its posterior and outer aspect. As the altered epididymis thus increases in size, the testis feels small and usually soft, more rarely one or two nodular masses are present in its substance. The patient's health suffers but little at first. After a varying period, usually three or more months, one of the nodules in the epididymis becomes enlarged, the soft parts over it are found to be adherent, becoming thinned; before long the skin, dusky red and purplish, and shining, at one spot gives way, and the characteristic discharge of ill-formed pus and caseous material follows. To this succeeds a fistulous sinus, from which weeps constantly thin sero-purulent discharge. Where such a sinus closes, a depressed adherent cicatrix remains; the affected part, whether epididymis or testis, being left smaller in size and irregular in shape.

Tuberculous epididymitis may result in permanent chokage of the canal of the epididymis and consequent sterility of the testicle.

Treatment.—This will be either medical and palliative, or operative. Medical treatment may be tried as long as the deposits are small and hard, but as soon as caseation has commenced surgical measures should be resorted to.

Uncomplicated primary tuberculosis of a single epididymis or testicle should be treated by immediate castration, for so long as the disease remains, extension to other parts is liable to occur. When other lesions of the genital tract are present, however, but little is to be gained as a rule by removal of the testicle. In rare cases where a testicle and a seminal vesicle of the same side are alone implicated, both structures may be taken away either at the same or different times with advantage. Where castration is contra-indicated but little permanent good results from active local surgical treatment. Abscesses may be left unopened until they are close to the skin, when they may be incised and treated afterwards with simple antiseptic dressings until they heal. The erosion of localised tuberculous lesions in the epididymis or the testicle is usually unsatisfactory in its final result.

Some authorities, however, advocate active local treatment in all caseating foci. Morris thinks that if improvement does not soon follow upon general hygienic and climatic treatment, some surgical operation will be requisite, and should be undertaken without further loss of time. He advises erasion of all the softened areas, and thorough rubbing of the cavities with iodoform, which in many cases has been sufficient to check the disease, and should always be tried first when the deposits are small and few, and there is no extension of the malady along the genito-urinary apparatus, or secondary deposits of tubercle elsewhere. When erasion has failed, when the fistulæ persist or are numerous, when there is fungus with a small wasted testis, and when the whole or greater part of the organ is involved, castration is the only treatment. A fungating tuberculous testis is better removed probably under all circumstances.

The general treatment of tuberculous orchitis is to be conducted on those lines which will best improve the general health—fresh air (night as well as day), good food, warm clothing, cod-liver oil, and tonics.

Tumours of the Testicle.—The following is a list of the tumours which, according to Ziegler, have been met with in the testicle:—Adenoma, adeno-sarcoma, chondro-adenoma, chondro-cystoma, cystadenoma, enchondroma, fibroma, cystic fibroma, myxoma, osteoma, papillomatous cysto-sarcoma, rhabdomyoma, dermoids, sarcoma, lympho-sarcoma, cysto-sarcoma, carcinoma, and chondro-carcinoma. From this list it may be seen that the testicle is liable to be affected by tumours with cyst-forming tendencies, and among these some—such as chondro-cystoma—are most peculiar to this organ. The pathology of testicular malignant growths has not yet been thoroughly worked out, for whilst at the present time some British pathologists hold that carcinoma is an unusual form of malignant disease of the testes, Continental writers, on the other hand, speak of it as one of the "commonest tumours" of this gland.

Nothing would be gained by treating each of the above varieties of tumour in detail; it is only necessary to refer at length to the more distinctive among them to which the testicle is liable to be affected.

Tumours. — *General Cystic Disease of the Testis.*—A name given by Curling to a form of adenoma formerly known as "hydatid disease of Astley Cooper." The morphology of these tumours has been independently investigated by Sutton and Eve. They originate in the remnant of the Wolffian body—the paradidymis, which lies between the globus major of the epididymis and the testes proper. In their typical condition these tumours are made up of large numbers of cystic spaces, varying in size from a rape seed to a cob-nut. Many are distinctly tubular, and the cysts may communi-

cate with each other. The loculi are lined with regular columnar, cubical, or stratified epithelium, and intra-cystic papillomata are not uncommon. The connective tissue framework of the tumour consists mainly of fibrous tissue, but it may be so abundant as to form the bulk of the tumour, the cysts being sparse. In some of the specimens, especially those met with in infants, plain muscle fibre has been detected, and in at least one instance hair has been found. As the tumour increases in size, it flattens the body of the testicle until it is reduced to a narrow stratum intervening between the tunica albuginea and the adenoma. In the large specimens it is often difficult to detect any remnant of the testicle.

Symptoms and Cause.—This form of cystic disease may affect the testicle at any age between birth and the fortieth year, most often in middle life. The tumours grow insidiously, painlessly, and slowly. They exist for several years, and may attain a moderately large size. They are smooth, uniform, and ovoid, but as they enlarge careful palpation may detect some spots softer and more elastic than others The spermatic cord and lymphatic glands are unaffected, and the general health is not impaired. Recurrence after removal is exceptional; metastasis is not unknown.

Castration is the only treatment, and ought not to be delayed.

Enchondroma of the Testicle.—The frequency with which cartilage appears in cystic sarcomatous tumours of the testis is noteworthy; it occurs also alone in hyaline masses which vary in number, and apparently without cysts or sarcomatous material, but though cases from time to time occur in which the masses of cartilage are united and surrounded by fibrous tissue—firm and well developed—without any admixture of softer material, yet clinically it is extremely doubtful whether any of these apparently simple enchondromata of the testis may not at any time become sarcomatous. We undoubtedly meet occasionally with small cartilaginous tumours of the testis which have been gaining slowly, perhaps for three or four years, and in which there is no recurrence after removal, yet it may be doubted whether a cartilaginous tumour of the testicle really deserves the term innocent.

Symptoms.—Enchondroma of the testis would be recognised by its hardness, its bossy or lobulated outline, its slow rate of growth, and its painlessness. The cord would be normal, and the general health unimpaired.

Early castration should always be performed.

Myoma and fibroma of the testis are exceedingly rare, and would scarcely be recognised as such until microscopical examination was made. Their clinical history would be that of similar innocent tumours elsewhere, and their treatment would be by enucleation or castration.

Teratoma.—These tumours, which are congenital and cystic, occur in two forms:—(1) Those containing fragments of bone, teeth, nervous tissue, or intestine; or (2) the more ordinary forms of dermoid cyst containing epithelium, hair, and sebaceous material. Both kinds are met with outside the testicle near its junction with the epididymis. Their mode of origin is uncertain. They may be noticeable at birth or not until a later period, and may remain quiescent or may become inflamed and suppurate. They tend to atrophy the testicle, and may possibly degenerate malignantly.

Their early removal is necessary, either by completely dissecting away every vestige of their sacs, or by excision of the testicle should the simpler procedure prove impracticable.

Sarcoma of the Testicle.—Sarcoma is probably the more common form of malignant disease of the testicle, the round-celled occurring most often, and the lympho-sarcoma next in order of frequency. The sarcoma have their origin in the intertubular connective tissues, and are rarely of pure form throughout their structure, being usually mixed with myxomatous and cartilaginous tissues.

Sarcoma of the testis usually commences in the body of the testis, appearing first as an oval or egg-shaped lump uniform in outline. It is this absence of any irregularity or bossiness which at first often makes it difficult to distinguish these cases from those of chronic orchitis, especially as the history of a blow and subsequent inflammation may be present in either case. Later on irregularity of outline and unequal resistance at different spots may both be met with. The tunica albuginea is usually not only distended, but also thickened; the cavity of the tunica vaginalis contains fluid at an early period, but later on it is usually obliterated. In section the sarcomata may appear uniformly fleshy or marked by fibrous septa, giving the growth a lobulated appearance. Microscopically the cells are round or spindle-shaped, occupying the intertubular tissues, separating and compressing the seminal tubes, many of which are altered in shape, and their epithelium degenerated into granular detritus. It is important to bear in mind that sarcoma of the testis is very prone to enlarge the nearest lymphatic glands, contrary to the rule of sarcomata in general.

Symptoms and Course.—The disease usually appears in healthy patients either in early childhood, or in manhood between the years of twenty-five and forty. It may be attributed to a blow or squeeze, but frequently is discovered by accident. The rate of growth varies with the exact nature of the tumour; as a rule it is rapid, but in some of the least malignant forms it may be slow. The tumour is smooth, symmetrical, solid, and heavy. Testicular sensation soon disappears, and pain is usually present.

The veins of the scrotum enlarge in time. The epididymis may become merged in the swelling. Both testes may be affected, especially in the round-celled variety, a complication which does not often occur in carcinoma. Secondary deposits are most common in the iliac and lumbar glands. They may occur also in any of the viscera. The prognosis in sarcoma of the testis is extremely bad.

Lympho-sarcoma of the Testis (Sutton).—These tumours are often described as "small round-celled sarcoma"; they occur in lads and young adults, often affect first one and then the other testicle after a variable interval, disseminate very rapidly, and speedily cause death. They are the most malignant of the sarcomatous tumours.

Treatment. — Early removal of the testicle offers the only chance of successful treatment. To wait until an accurate diagnosis is certain is only to wait too long, chiefly for the reason that the abdominal lymphatic glands are quickly affected in testicular sarcoma. It is important, therefore, in every case to examine carefully by palpation for enlargement of the iliac, pelvic, and lumbar glands before submitting a patient to operation, no matter how early it may have been seen. It is desirable in operating to follow the cord along the whole length of the inguinal canal, by splitting the fibres of the external oblique muscle to the extent necessary, as is done in radical cures of hernia. The cord can be traced and divided in the subperitoneal tissues, and the weakened inguinal canal sewn up as in Bassini's operation for hernia, etc.; the lower or arched edge of the internal oblique muscle being sewn to the inner surface of Poupart's ligament before the external oblique is brought together over the canal. In those cases where the scrotal tissues are not invaded by the new growth the skin incision is best made from a point opposite the external abdominal ring obliquely downwards to the upper part of the scrotum, the testicle being squeezed upwards from the scrotum through the wound. If the scrotal tissues are invaded by the growth, the affected area must be widely removed between elliptical incisions continuous with the one already described. Any secondary swelling within the abdomen contra-indicates castration as a possible curative measure, as it is useless trying to excise these secondary masses.

Carcinoma of the Testicle.—Carcinoma takes the form either of soft marrowy growths (encephaloid or medullary), or of firmer or more compact tumours with an abundant stroma (scirrhus). It often happens that different parts of the same growth differ in structure. The disease usually starts in the convoluted seminiferous tubules. The cancer cells are exceptionally prone to mucoid and fatty degeneration, and in the softer forms hæmorrhage is very common; sections of such growths are apt to be mottled with various tints. Cysts with gelatinous or colloid contents are produced by the mucoid or colloid degeneration of the cells in the cancerous loculi, the tumours being then described as cysto-carcinoma or colloid carcinoma. Carcinomata, likewise, in many cases contain rounded nodes and nodules, or elongated, ramified, and cactus-like patches of cartilaginous tissue, chiefly in the neighbourhood of the rete testis and epididymis. These patches as they grow sometimes break into the lymphatics and seminal canals of the testis, and therein ramify, assuming the most diverse forms (chondro-carcinoma). In cases of carcinoma of the testis the fibrous stroma of the growth itself, or that of the epididymis, sometimes undergoes sarcomatous proliferation. Metastasis takes place both through the blood-vessels and through the lymphatics.

Encephaloid Carcinoma. — The mass of an encephaloid carcinoma has a soft, pulpy consistence, and a more or less uniformly white or pinkish white colour. When squeezed a creamy fluid oozes from its cut surface. It is usually so soft and so fragile that it is liable to give way under slight injury, and blood becomes effused in its substance. This may take place at many points interstitially or into ragged cavities. The effused blood, undergoing changes, gives rise to a variety of appearances and discolorations.

As the growth increases, the coverings of the testis yield under pressure, and become stretched to a great extent before they give way, and even when the tunica albuginea has yielded the scrotum continues to expand. In course of time, however, the tumour becomes adherent to the scrotal tissue and ulcerates through them, and the true fungus hæmatodes appears growing rapidly, with a sloughy surface which bleeds readily. The surfaces of the tunica vaginalis are usually more or less adherent, and the cavity sometimes contains blood-stained serum. The growth extends to the cord, and affects the pelvic and lumbar lymphatic glands. Secondary deposits are found in the lungs and other situations.

Symptoms of Soft Carcinoma of the Testis.— The testis is at first occupied by a regular oval or pyriform mass. This is at first rather firm, but soon the mass becomes softer at some parts than others, and has a pulpy, elastic, or fluctuating feel. Its weight is heavy. Pain and tenderness are not conspicuous symptoms. Testicular sensation is early lost. The scrotal veins enlarge. Thickening of the cord is an early feature; separate masses of growth can sometimes be felt within it. Enlargement of the intra-abdominal lymphatic glands (lumbar and pelvic) is an early incident, and must always be carefully looked for before any operation is advised. As the growth becomes larger irregular bosses form on its surface—

some hard, some soft—the scrotum becomes adherent, gradually discolours, and the mass from within fungates through. Cachexia is not a marked or early symptom. It is, indeed, usually absent until long after the time when any attempt at curative treatment might have been made.

Scirrhus of the Testicle.—This form of carcinoma is extremely rare in the testicle, and its existence has even been denied altogether by many pathologists. Cases have, however, been described, and the following are among its best-marked features:—It appears later in life than encephaloid carcinoma. Its course is slow, extending to six or more years. The size is not great, but the hardness is extreme. Microscopically it consists of very thick connective tissue trabeculæ in which the alveoli contain polymorphic epithelial cells.

Treatment of Carcinoma Testis.—Carcinomatous tumours of the testis can be treated, of course, only by castration, and in any case of doubtful diagnosis it is better to explore a scrotal swelling and find a mistake in diagnosis has been made than to postpone interference until a positive opinion of the nature of a tumour can be formed, only to find that the time has gone by when successful operation might have been undertaken. The principles of operation are those described when treating of sarcoma.

Fungus or Hernia Testis.—This term is applied to a protrusion from within of testicular tissue through the tunica albuginea and the skin of the scrotum. It occurs in connection with inflammatory or with malignant disease, and is seen therefore in two forms—benign hernia testis and malignant hernia testis.

In the malignant form the protruding mass (fungus hæmatodes) consists of new growth, and contains no testicular tissue. In the benignant form the protrusion consists of much granulation tissue and little testicle substance, and is usually a product of syphilitic disease, although it may sometimes occur from tuberculosis. Fungus due to tubercle generally springs from the epididymis, whilst that of syphilis springs from within the substance of the testicle.

The recognition of these conditions is simple enough, and the diagnosis between benignancy and malignancy must be made by a general survey of the history and surrounding circumstances of the case.

Treatment.—Malignant hernia testis can be treated only by castration. The benignant form, if small and tuberculous, may sometimes be cured by dusting powdered iodoform over the fungus, and attending at the same time to the constitutional condition; the syphilitic form should be dusted with calomel or peroxide of mercury; and iodides, mercury, and tonics administered internally. In this latter form strapping may sometimes with advantage be applied; and this failing, Syme's operation may be performed. To secure success by this operation it is necessary, in the first instance, to bring the surface of the fungus into a healthy granulating condition by one of the treatments just mentioned. The parts are then made as aseptic as possible, as in any operative procedure; the edges of the circular opening in their whole thickness of the scrotum are freely excised, and are then deeply undercut all round, and to an extent sufficient to allow quite easily of their being brought together over the fungus, where they are secured by closely applied interrupted sutures of wire or fishgut. It is sometimes necessary to shave part of the fungus away before suturing. In obstinate cases of benignant hernia castration is the only remedy, and should be the usual treatment in the tubercular form.

Leprosy of the Testis.—The testicle is a locality of early and constant implication. The gland is often affected when apparently normal, and its function may be compromised or entirely destroyed during the first or second year of the disease. In a typical case the changes are chiefly interstitial—proliferation of the intercanalicular septa and membrana propria, with resulting compression of the canaliculi. Necrotic foci may appear in the infiltration. The cord remains intact for a long time.

Neuralgia of the Testis — Testalgia. — Neuralgia of the testis is characterised by sudden, severe, and paroxysmal pain; it may be due to causes situated in the testicle itself, or in some distant part. The causes situated in the testicle are contractions of inflammatory deposits, minute abscesses, fibrous bodies in the tunica vaginalis, small encysted hydroceles, progressive atrophy, small new growths, *e.g.* fibro-myoma, or injury to the vas deferens.

Causes situated at a distance from the testicle are irritation in the prostatic urethra, stone in the bladder or kidney, chronic inflammation of the seminal vesicles, oxaluria, lithiasis, gout, rheumatism, and extreme nervous depression associated with phosphaturia and constipation; fissure or ulcer of the anus or rectum are also occasional causal conditions.

Treatment.—Where possible the cause should be ascertained and removed; where this is not possible the testis should be suspended, bowels daily evacuated, diet regulated, horizontal rest enjoined, and ice or hot fomentations, or an anodyne liniment—such as opium or belladonna—applied locally. Morphia may have to be injected occasionally. Division of the nerves of the spermatic cord and castration have been practised, but are not to be recommended, except in the rare cases of neuralgia from a new growth, or from the contraction of some old inflammatory thickening in the epididymis or testis, which no other methods have succeeded in improving.

Methods of Supporting or Suspending the Testicles.—An endless variety of bandages have been devised for this purpose, and "suspenders" of different kinds are to be found at every drug store or surgical instrument maker's. The chief fault of suspenders lies in the fact that they fit only by accident; as a rule they are too tight in some parts, and too loose in others, so that the uniform compression which is essential to the relief of swollen and tender parts cannot be secured by their aid. Fortunately, however, more than efficient substitutes are easily and simply made.

The testicle can be well supported by two handkerchiefs, either of silk or cotton—preferably the former—applied in the following manner: A handkerchief is folded corner-ways to the width of an ordinary belt and is then tied securely round the waist. The second handkerchief is folded once corner-ways into a triangle. The centre of its base, with the apex forwards, is placed behind the scrotum, and its "angular" ends are then brought forwards on either side of the genitals up to the "waistbelt," where they are secured. The apex of the triangle is now brought forwards over the scrotum, and is carried upwards in the median line to the waistbelt, under which it is passed and turned down and fastened securely with a safety-pin; the pressure on the swollen parts being determined by the tightness of this apical portion of the triangle.

Von Baer's Triangle.—A better method of securing a dressing on, or of supporting, the scrotum or testicles is by means of "von Baer's triangular bandage," which is applied as follows: An eighteen-inch square of surgical lint or other soft textile, from which the selvage has been torn, is cut from corner to corner into two equal triangular halves. To the rectangular apex of one of these is sewn two twenty-inch lengths of two-inch bandage, and to each of the angles at the base is sewn a thirty-six-inch length of the same. The triangle is now laid over the genitals and hypogastrium, with its base upwards and its apex reaching behind the scrotum to the perineum, where it is firmly held by passing one of the strips attached to it under each thigh along the gluteal fold to the outer side of the great trochanter, where they are firmly held by an assistant so as to prevent the triangle being drawn forwards. The strips attached to the angles at the base of the triangle are now carried, one in each direction, round under the pelvis, and are brought forwards between the iliac crest and great trochanter across the triangle about one inch below its base, and are tied firmly together in the middle line. The strips from the outer side of the thighs are now carried forwards and inwards across the outer third of the groin, and are fastened with safety-pins to the base of the triangle, which is turned down to meet them over the strips which have encircled the pelvis. An opening is lastly made in the triangle, through which the penis is drawn.

On "Strapping" a Testis.—The whole scrotum must be shaved. The affected testis is separated from its fellow and gently pressed into the lowest part of the scrotum. A strip of adhesive plaster, three-fourths of an inch wide and twelve inches long, is now bound transversely round the scrotum above the testis, sufficiently tight to prevent the testis slipping back through it. A second or even a third circle of strapping is applied below the first, pressing the gland more and more downwards. Longitudinal strips are then applied, reaching from the encircling strapping on one side over the testis to the other side. These strips overlap each other, and are repeated until the gland is well covered in. A final strip of encircling plaster is bound round the "neck" of the swelling to make all secure, and the scrotum is finally supported in a suspensory arrangement of some kind. If thought necessary, ointments spread on lint may be applied under the strapping. The dressing should be changed as soon as the imprisoned testicle is found to be shrunken within it.

Excision of the Testicle (Castration).—The pubes and scrotum must be shaved and made aseptic. An incision through the skin and deeper tissues is made from the external abdominal ring to the bottom of the scrotum, and the cord and testis laid bare. The cord is now isolated close to the external ring, the testis squeezed out of its bed, and the soft parts which attach it to the scrotal tissues divided freely until the testicle is held in by the spermatic cord only. The cord may now be dealt with in several ways, but whichever method may be adopted it is important to have a secure hold of its central end until all its vessels have been secured. It may be transfixed with an aseptic stout double silk ligature, which is divided at its looped extremity, each half tied separately about its own section of the cord, and the cord then cut through half an inch below the ligature; or the cord may be caught temporarily in a clamp or with artery forceps, divided an inch below, and the vessels on its divided face caught separately or in small clusters, and tied as in an ordinary amputation. The position of the vessels in the cord has been referred to (p. 85). Three arteries must be included in the ligatures—the artery to the vas deferens, the cremasteric, and the spermatic. It is often impossible to identify the arteries from the veins. The mouths of the latter vessels gape when divided; they are readily seen and easily secured. Both veins and arteries together are picked up with artery forceps, and secured with silk or catgut ligatures. The two sets of veins may be tied in separate masses. If the scrotal tissues are invaded by disease the affected area must be

taken away between elliptical incisions running wide of the lesion. In operating for malignant growths it is desirable to remove the cord as high up as possible, and for this purpose the external oblique must be slit up in the length of its fibres from the external to the level of the internal ring. The inguinal canal can then be thoroughly cleared, and the whole extra-peritoneal part of the cord removed. The lower arched edge of the internal oblique and transversalis muscles can be sutured to the inner surface of Poupart's ligament with continuous silk or catgut sutures, as in Bassini's operation, and the divided sides of the external oblique muscle overlapped as in the operation for radical cure of hernia. Where a testicular tumour is small or of moderate size, and the scrotal tissues are not invaded, it may be removed by an oblique incision made at a higher level than the one above described. The tumour being forcibly squeezed up on to the pubes, an incision is made over it sufficiently long to allow of its extrusion, and not encroaching upon the scrotum if it can be avoided. The cord is isolated and divided as above described, and the testicle cut away from its scrotal attachments, in doing which it is important to secure bleeding vessels as they are divided, otherwise they are drawn back deep into the scrotal pouch, where they are difficult again to find, and where also they may be easily overlooked until a subsequently developed hæmatoma indicates their presence. In castration for tubercular testis the vas deferens may be separated from its own artery, and torn away by traction in its length from its deeper attachments to the bladder wall and prostate. In this way the whole of the vas may be safely removed; a great advantage in those where an affected seminal vesicle is also to be taken away. Before wounds in the scrotum are closed it is very desirable to tie every bleeding point, as hæmatoma forms so readily in the loose tissue of this part, and is liable to break down and delay union. A post-operative scrotal hæmatoma should be cleared out at once by separating the lips of the wound to the necessary extent, the leaking vessel found if possible and the parts being subsequently well supported by means of softly compressing dressings.

Scrotal wounds should be sutured through their whole thickness, and care taken that the sutures are not too tightly tied. Drainage for twenty-four hours is generally desirable, and is best made through the upper angle of the wound.

The wound is dressed with dry aseptic gauze dressings, and the scrotum carefully supported by means of a von Baer's triangle. Drainage may be dispensed with in twenty-four hours, and sutures removed on the fifth day.

Hydrocele.—Under this term is described the "watery," fluid collections which are formed in and about the tunica vaginalis, epididymis, testis, and cord in men, and the round ligament in women. Hydroceles should always be regarded as symptomatic until the existence of disease or defect in the parts about which they form has been negatived, either with or without the aid of puncture.

Hydroceles in females are treated of in the section on diseases of women (*see* vol. iii. p. 250).

Hydroceles in males are divided into those of (1) the tunica vaginalis, (2) the testis, (3) the epididymis, and (4) the spermatic cord.

Hydroceles may be either acute or chronic; the latter largely predominating.

Hydroceles of the tunica vaginalis are of the following kinds:—Vaginal, congenital, and infantile.

Acute vaginal hydrocele is seen in traumatic orchitis, acute epididymitis, and after injection for the cure of a hydrocele. Its pathological and clinical phenomena, its consequences, and its treatment are described in connection with the radical cure of vaginal hydrocele by injection.

Chronic Vaginal Hydrocele.—This consists of a collection of fluid in the sac of the tunica vaginalis, and appears either as a primary or a secondary condition. It is to the former that the term vaginal hydrocele is ordinarily applied, and which alone is dealt with in this section.

The secondary hydroceles are vaginal, inasmuch as they are effusions into the vaginal tunic, but they depend upon syphilitic, tuberculous, or simple chronic inflammation of the testis or epididymis, and are dealt with, therefore, in connection with these several affections.

The causes of primary vaginal hydrocele are very obscure, and little is known positively concerning them. In the great majority of cases hydrocele commences insidiously and without any apparent cause. It is, as a rule, quite independent of any inflammation, and is a mere passive effusion due to the anatomical and mechanical conditions of the vessels and circulation of the cord and testicles. A not uncommon cause is found in the presence of fibrous bodies attached or free within the vaginal tunic. They are usually attached, are sometimes cystic, and not infrequently calcify. The hydatid of Morgagni furnishes a certain number of them.

The fluid from the vaginal hydrocele is usually yellow, but may vary from a pale straw to a turbid green or bronze. It is odourless, limpid, and transparent. It is neutral in reaction, with a specific gravity about 1025; it contains much albumin and a small amount of fibrinogen. Under the microscope only a few small cells are to be seen. Not infrequently it contains cholesterine scales, which in old-standing cases become very plentiful and fill the fluid with glistening particles. The quantity of fluid contained in a vaginal hydrocele varies between ounces and pints.

If the hydrocele has been unirritated the tunica vaginalis remains for long unchanged, but in old, neglected, or injured hydroceles the tunic becomes hard, thickened or calcified throughout or in patches.

Symptoms.—A pyriform swelling on one side of and limited to the scrotum, with a smooth and uniform outline, elastic to touch, translucent, dull on percussion, and giving no impulse on coughing, is characteristic of vaginal hydrocele. One side is as often affected as the other, and sometimes both are affected together. The shape is occasionally round, sausage-shaped, or constricted, like an hour-glass (hydrocele *en bissac*). Translucency may be wanting, either because of the opacity of the fluid from admixture of blood, the presence of cholesterine; from the milky, thickened, or curdy nature of the fluid in some old hydroceles, or from opacity due to the thickening of the tunica vaginalis or other tissues of the scrotum. Fluctuation may be obscured by tension or by thickening of the sac wall. Testicular sensation is present at the back of, and towards the lower part of the swelling. The increase in size is slow and painless; dragging sensations are referred to the groin and loin. When there is a large hydrocele on both sides, the skin of the penis may be so much dragged upon that the body of the penis becomes obscured, and the opening of the preputial orifice is all that remains to be seen of the organ.

Diagnosis. — Hydrocele is to be diagnosed from scrotal hernia, from hæmatocele, from orchitis and epididymitis, from solid tumours. A swelling in the scrotum or inguinal canal which is (1) circumscribed, (2) fluctuant, and (3) transparent is a hydrocele of some kind; and having established a diagnosis thus far, the several varieties of hydrocele are to be distinguished from each other by the following signs:—

Vaginal hydrocele, large and uniform; pyriform or round, does not encroach on the inguinal canal; does not lessen under pressure or in the recumbent position; has no impulse on coughing; testicular sensation present; and testis appears by transmitted light as a dark shadow posteriorly.

Infantile hydrocele differs from vaginal in that it fills up the inguinal canal (it may extend into the abdomen) and has an impulse on coughing.

Congenital hydrocele differs from infantile hydrocele by lessening on pressure and disappearing on lying down; its impulse is direct and constant.

All the *hydroceles of the cord* are smaller and more elongated; the testis can be felt below the swelling and can be separated from it.

Diffused hydrocele of the cord is always more or less sausage-shaped, and when punctured a clear fluid comes away in spots instead of in a steady stream.

Encysted hydrocele of the epididymis is usually lobulated and rarely of large size; the testis is below and inseparable. The chief distinction is found after tapping, in the watery character of the withdrawn fluid, its low specific gravity, the comparative absence of albumin, and the presence of spermatozoa.

Treatment of Vaginal Hydrocele.—Spontaneous cures occur occasionally in children, but are not to be looked for in adults. In the young the fluid may be absorbed under stimulating lotions, or by frequently painting small patches of tincture of iodine on the scrotum over the swelling; in adults the hydrocele may disappear after an attack of inflammation of the testicle, the cavity of the tunica vaginalis becoming obliterated probably by adhesive inflammation, such as occurs after treatment by injection. It is on account of its bulk, weight, or unsightliness—not because of pain or danger to life—that treatment of hydrocele is required. In young persons damage may be done to the testicle owing to the dragging effects on the vas deferens and epididymis, and to the atrophy of the testicle by thickening of its tunica albuginea and fibrosis of the gland tissue. Palliative treatment consists in draining off the fluid by tapping with a fine trocar and cannula. The position of the testicle should always be carefully made out in order not to wound it with the trocar, and in making the puncture cutaneous and deeper veins must be carefully looked for and avoided. A point for puncture in ordinary cases is chosen on the front of the scrotum, at the junction with its upper and middle thirds, where the skin should be carefully cleansed with methylated spirit before the puncture is made. A standing patient is most convenient for the operator; or he may sit on the extreme front of a chair, with his body leaned back, and his legs extended and spread widely apart. A trocar and cannula of the size of a No. 2 catheter must be carefully sterilised. This can be done by boiling them in a test-tube over a spirit-lamp for a few minutes just before using. The surgeon stands or sits in front and to the right of the patient, grasps the scrotum from above and behind in his left hand, making the tissues tense over the swelling. The trocar is held in the right hand, with the index finger on the cannula about an inch from its end, for the purpose of marking the depth to which the instrument is to be thrust. A rapid, firm stab is made in a direction backwards and upwards as far as the index finger will allow; and as the trocar is withdrawn out of the cannula, the cannula must be pushed on into the scrotum nearly to its end, so as to avoid the slipping off from it of the contracting and receding proper tunic of the hydrocele. The fluid will escape through the cannula without pressure, but it is better to keep the left hand supporting the tumour until it is empty. When the fluid has ceased to flow

the end of the cannula should be closed by the tip of a finger, and the instrument quickly withdrawn; the edges of the puncture being held together between finger and thumb, and sealed with a little flexile collodion or strapping. The scrotum should be thickly covered with aseptic cotton-wool and supported with a handkerchief or suspensory bandage. It is advisable for a patient to keep quiet for a few hours afterwards. Faintness is occasionally seen. The risks of the operation are the wounding of a vessel in the scrotum, puncture of the testis, and local septic infection and its consequences.

The Radical or Curative Treatment.—The methods employed for the radical cure of vaginal hydrocele are (1) injection, (2) incision, and (3) excision.

(1) *The Injection of Irritating Liquids.*—This is a safe and usually satisfactory method of treating small and moderate sized simple hydroceles in which the sac is not greatly thickened or indurated, and where no loose or pedunculated bodies are present within it. It is inapplicable to children and feeble old men. Recurrences are seen in about 5 per cent of cases treated by injection. Of the many liquids which have been employed, mention only need be made of two—tincture of iodine and liquefied carbolic acid. The injection with iodine should be carried out as follows:—The skin of the scrotum and the instruments must be made aseptic. The fluid is carefully drawn off with a medium-sized trocar and cannula. By means of a glass syringe about two drachms of a 5 per cent freshly prepared sterile solution of cocaine or eucaine are injected through the cannula, left for about a minute, and then allowed to escape. About half an ounce of tincture of iodine is now similarly injected, and the opening in the cannula closed. The sac is freely manipulated and shaken to insure its every part coming in contact with the iodine, about half of which at the end of ten minutes is allowed to escape, and the cannula is withdrawn; the sides of the puncture being squeezed tightly about the instrument to prevent the escape of iodine into the connective tissues. The puncture is sealed with collodion or strapping. The patient should be at once put to bed for a few days, the scrotum supported, and a plain diet given. Within twenty-four hours, as a rule, the scrotum is swollen, hot, and tender, and an evaporating lotion of lead and opium should be constantly applied to the part. Within a week usually the patient may get about again, wearing a suspensory bandage; but all swelling does not disappear until the end of three or four weeks. Instead of tincture the following iodine solution may be used:—Iodine, 40 grains; iodide of potassium, 30 grains; water, one ounce. The pain experienced after the use of iodine varies much, but the acute pain of the injection is very much lessened—often entirely neutralised—by the use of the preliminary cocaine injection.

The injection of carbolic acid has been more popular in America than in this country. It has advantages of its own; is quite as effective as iodine, and certainly causes less pain, where cocaine has not been used. After the usual tapping by means of a syringe having a nozzle sufficiently long and slender to reach entirely through the cannula, about one drachm of pure carbolic acid, liquefied with glycerine, is injected and allowed to remain—the sac being freely manipulated for the purpose of distributing the acid freely over its interior. A sense of warmth is produced, which is quickly followed by a decided numbness. Subsequent treatment is practically the same as where iodine has been employed.

The mode of cure in either case is either by universal or partial adhesion of the parietal to the visceral portion of the tunica vaginalis by organisation of the fibrinous products of plastic inflammation; or by converting the serous membrane to a dull, dry, fibrinous condition without power of secreting.

The untoward effects and accidents that may follow these injections are: excessive inflammation, cellulitis, sloughing, suppuration in the sac, or abscess in the scrotal tissues. Recurrence may take place after each method; indeed hydrocele occasionally recurs after every known method of treatment.

Operative Treatment.—The open method of treatment by incision or by excision of the whole of that part of the tunica vaginalis which lines the scrotum, but without attempting to interfere with that covering the testis or epididymis, should be employed in preference to injection in the following cases:—(1) Where the sac is very thick, cartilaginous, or calcified; (2) When there is no doubt that the hydrocele is of the congenital variety, or is a hydrocele of a hernial sac with a small opening into the peritoneum; (3) Where hernia complicates hydrocele, and a radical cure of both is desired; (4) When loose or pedunculated fibrous bodies are present in the tunica vaginalis; (5) When there is no doubt as to the absence of serious organic disease of the testis; (6) When a vaginal hydrocele is associated with a hydrocele of the cord and an inguinal hernia.

Treatment by Incision.—The scrotum having been shaved and the parts sterilised, the tumour is grasped firmly behind, and a vertical incision one and a half to two inches in length is made along the anterior and lower aspect of the swelling. All bleeding points having been carefully secured, the tunica is opened and the fluid allowed to escape. The cut margins of the tunica vaginalis and skin are stitched together by catgut sutures—interrupted or continuous. A wick of iodoform gauze or a large drainage tube is introduced into the

hydrocele cavity, and the operation is complete.

The patient must lie in bed for about two weeks; the scrotum must be well suspended, and the wound aseptically dressed with dry absorbent dressings. Care must be taken that no bagging occurs; all drainage as a rule may be dispensed with in two or three days. Patient will be getting about at the end of the third week, but should wear a suspender of some kind for some months afterwards.

Treatment by Excision of the Parietal Part of the Sac.—The scrotum is grasped firmly behind, and the tissues over the hydrocele made tense. An incision three inches long is made over the front and lower part of the tumour, down to the usually transparent and almost structureless tunica vaginalis, which can best be freed from most of its external attachments in its tense and unopened condition; the hydrocele being extruded out of the wound, except at its posterior and lower attachments. The sac is now to be opened and cut away close to the testis and epididymis, but without injuring those structures. All bleeding points are to be carefully tied, especially those in the thicker parts of the sac through which the "freeing" incision has been made. A drainage tube is inserted in the cellular tissue-space from which the sac has been removed and the edges of the external wound brought together by sutures. An aseptic dry dressing is applied, and the scrotum raised and supported. Drainage may be dispensed with in twenty-four hours, and the parts kept dry. Rest in bed for two or three weeks afterwards is desirable.

Treatment by excision is the most radical of all the above methods, but recurrence has been recorded even after this operation.

In troublesome or rebellious cases—particularly in elderly men—castration through an inguino-pubic incision is sometimes the safest procedure to adopt.

Congenital Hydrocele.—In this condition the cavity of the tunica vaginalis is continuous upwards with the cavity of the peritoneum, and depends upon non-closure of the funicular process of peritoneum along which the testis has passed from the abdomen through the inguinal canal into the scrotum. The size of the communication with the peritoneum may vary from a thread to a finger end. Though generally met with in infancy and soon after birth, it may not develop until later in life.

Where such an anatomical condition is present the fluid contained in the hydrocele may have come downwards from the peritoneum, and often does so in the serous form of tuberculous peritonitis in children.

Treatment.—Simple measures may be tried in children, and careful tapping is admissible, but radical treatment for its permanent relief is the soundest procedure. The sac must be exposed and isolated, like the sac of a hernia, and after its neck has been tied it may be cut away. Truss treatment is uncertain and usually unsatisfactory, and the injection of irritants is mentioned only to be condemned as dangerous.

Infantile Hydrocele.—In this condition the sac of the tunica vaginalis extends upwards along the cord to the inguinal canal, or even beyond into the abdomen. The hydrocele is closed at its upper end, and has no open communication with the peritoneal cavity, although the two sacs may lie in close contact with each other. There are two varieties of infantile hydrocele: (1) inguinal; and (2) abdominal. In the inguinal variety, which is by far the more common, the upper limit of the sac is in the inguinal canal, usually at one or other of the rings. In the abdominal variety—a very rare form—the sac extends through the whole length of the inguinal canal, where it is more or less constricted, along the cord structures into the abdomen, where it becomes larger again, and may reach as far as the loin. It is sometimes described as a form of hydrocele "*en bissac.*"

Treatment.—In the inguinal form puncture is a safe procedure, but should this fail excision of the whole of the sac from its uppermost limits downwards to the testis must be practised. The operation on the abdominal variety is a somewhat difficult and dangerous one, and ought not to be attempted except where there is a clear reason for interference, as death has followed the procedure.

Funicular Hydrocele, or Hydrocele of a Hernial Sac.—This term is applied when the sac of a hernia—either congenital or acquired—emptied of its hernial contents, and either partly or wholly shut off from the peritoneal cavity, becomes distended with serous fluid. The congenital variety is the most common, and is sometimes described as congenital hydrocele of the cord, a term which exactly expresses its anatomical condition: it consists of an open pouch of peritoneum which extends into the inguinal canal, and is quite separate below from the tunica vaginalis. The acquired variety is rare, and although often confined to the inguinal region, may extend into the scrotum; sometimes after the reduction of its hernial contents the neck of the sac is obliterated by the pressure of a truss; or the orifice is completely obliterated by a plug of adherent omentum, or again the sac may communicate with the peritoneal cavity by a very narrow channel.

Symptoms and Diagnosis.—The congenital funicular hydrocele has many of the characters of congenital vaginal hydrocele, but it does not extend so far into the scrotum, and the testis can be seen and felt below it. In the acquired variety there is usually the history

of a hernia and the wearing of a truss. The swelling may be inguinal or scrotal; it is fluctuant and translucent, and diminishes on pressure only if the opening into the peritoneal cavity is patent. It occurs later in life, is of larger size, and contains a darker coloured fluid than encysted hydrocele of the cord.

Treatment.—Simple tapping may be tried, but if anything further has to be done the complete removal of the sac on the lines followed in radical cure of hernia should be the treatment.

Inguinal hydrocele is the name given to vaginal hydrocele when the testis is undescended, and occupies a position somewhere between the internal abdominal ring and the scrotum; or the testis may have passed through the external ring, and be situated between the aponeurosis of the external oblique muscle and the integuments. It presents itself as a tense, fluctuating, translucent swelling, irreducible, often with an impulse on coughing. The empty half of the scrotum and the testicular sensation at the site of swelling make the diagnosis complete. If anything more than simple tapping is required, excision of the sac with the testis is the best treatment, the weakened canal being secured against any tendency to subsequent hernial protrusion by closure, as adopted in operations for the radical cure of inguinal rupture.

Hydrocele of the cord may be diffused or circumscribed.

Diffuse or Infiltrated Hydrocele of the Cord.—This is a very rare affection, and was first described by Pott. Its existence has been doubted by many authorities, but of its occasional occurrence the writer can speak positively from his own experience. The spermatic cord is enveloped by a loose layer of connective tissue, which unites its several constituents and is continuous above with the sheaths of the abdominal muscles, while below it may be traced over the epididymis continuously with the subserous connective tissue beneath the tunica vaginalis. The cremaster muscle is spread out upon its outer surface. This connective tissue, which is described by some anatomists as a separate fascia, the tunica vaginalis communis, becomes occasionally the seat of a diffuse serous infiltration. This is probably of the nature of an œdema, but its causes are obscure. This connective tissue is very rich in lymphatics and small veins, and probably any obstruction from pressure above and within the abdomen will produce the diffuse hydrocele.

Symptoms.—The swelling is uniform, cylindrical, or pyriform, with the large end downwards. The base of the tumour is formed by the firm fibrous tissue, which just above the testicle forms a septum below which the effusion cannot extend. The smoothness and uniformity of outline are due to the fluid being bound down by the tunica vaginalis communis. The cord is larger than usual, and feels somewhat like a soft omental hernia. Testis and epididymis below are normal. Pain is absent, discomfort from the dragging weight is felt in the loin. By gentle and continued pressure the swelling can be made to recede, but it returns quickly when the pressure is removed, and that as readily when the patient is lying down as when he is erect.

Diagnosis is difficult and uncertain, it resembles most closely an old thickened omental hernia; both extend upward along the cord into the inguinal canal; both feel somewhat dense, but little yielding to pressure, and neither is sensitive to handling. The points of distinction are chiefly the marked cough impulse in the hernia, its lobular or granulated feel, its complete reducibility, leaving the cord and external abdominal ring free and clear. Where such a hernia is irreducible diagnosis is very difficult, and can only be determined when necessary by careful puncture or incision. From an encysted hydrocele the diffused form may be known by its less clearly marked and less rounded outline, its extension upwards, and the alteration produced on it by pressure.

Treatment.—Unless this form of hydrocele attains a large size and becomes consequently a real incumbrance, it is better left alone. It cannot be satisfactorily emptied by tapping, as the fluid comes away drop by drop only, and is secreted almost as quickly as it escapes. If for any reason radical treatment is called for, complete aseptic excision of the tumour along with the testis and cord as high up as possible is probably the least dangerous treatment.

Encysted hydrocele of the cord is the term applied to circumscribed serous collections in the spermatic cord which have no connection with the tunica vaginalis. They occur in any part of, and affect any extent of the cord, but they are most commonly met with in the inguinal canal, and are usually of short length. More than one may be present. They are due to effusions into unobliterated portions of a funicular process which has become shut off at its upper end from the peritoneal cavity, and at its lower from the tunica vaginalis. They are met with in young patients, usually on the right side, as ovoid or elongated circumscribed tumours, smooth, painless, elastic, and translucent. They are apparently freely mobile, and when of short length may be pushed or coughed in and out of the inguinal canal, either towards the peritoneum or scrotum, in the readiest manner. They are often mistaken for hernias because of their marked indirect impulse on coughing, but are easily distinguishable therefrom by their translucency and by their tension, without symptoms of strangulation or discomfort of any kind. Exploratory puncture with

a hypodermic syringe readily reveals their nature. When situated at the lower end of the cord and of large size they resemble a vaginal hydrocele or an encysted hydrocele of the epididymis, but can be distinguished from these conditions by the testicle below being separable from the tumour.

Treatment.—Tapping may be tried for their relief in the first instance, but should they refill, complete excision is a safe and radical procedure. Enucleation more accurately describes the removal of these cysts than excision; for if care be taken to cut quite down to the proper sac of the hydrocele, which may be distinguished by its thinness over its containing fluid, and by the entire absence of blood-vessels from its walls, the unopened cyst may be shelled out of its bed without difficulty.

Hydrocele "*en bissac*" is a term applied (1) to a vaginal hydrocele which is constricted transversely at some part, and has in consequence assumed the shape of an hour-glass; the constriction depending on a localised structural resistance in the walls of the tunica preventing uniform distension of the sac, and (2) to the abdominal variety of infantile hydrocele already described (p. 104).

Encysted Hydrocele of the Testis and of the Epididymis.—The fluid is contained in a sac distinct from that of the tunica vaginalis; the conditions must be distinguished from hydroceles of the cord and of the tunica vaginalis. It occurs in two varieties:—

Encysted hydrocele of the epididymis.
Encysted hydrocele of testis (proper).

Encysted hydrocele of the epididymis is not uncommon in middle-aged and elderly men. Two forms have to be distinguished:—1. The commoner, consisting of large cysts containing spermatozoa, and originating within the epididymis. 2. The rarer, consisting of small subserous cysts outside the epididymis and not containing spermatozoa. The latter are small sessile or pedunculated cysts, rarely as large as a pea, contain a little serum only. They give rise to no symptoms, and call for no treatment. They are developed from the so-called hydatid of Morgagni, which is a remnant of the Müllerian ducts.

The larger variety of cysts is much more important. They are usually found close to the upper part of the epididymis, and arise inside its parenchyma. They are often multiple, and may attain the size of an adult fist. They increase slowly in size, and are composed of delicate fibro-cellular tissue, lined by stratified, cubical, columnar, or ciliated epithelium. Their contents are limpid and colourless, or opalescent, of low specific gravity (1004), alkaline, contain only a trace of albumin, and are rich in salts, chiefly sodium chloride. They usually contain spermatozoa, which are sometimes quiescent and disintegrating, sometimes immature, but sometimes showing lively movements and well-developed structure. The origin of these cysts has been much discussed. They may begin in an efferent seminal tube, or as a simple serous cyst, into which a tube opens, or, what is more probable, from Kobelt's tubes. Sutton has remarked, "It is a curious fact that these cysts arise in those structures which in the female give rise to parovarian cysts, and are therefore morphologically homologous with them."

Symptoms of Encysted Hydrocele of the Epididymis.—These are little marked at first, the onset being very insidious, and the growth slow. While small these cysts feel something like and have been mistaken for an additional testicle. Their shape is often globular and somewhat bossy. When large or multiple the outline becomes irregular or pyriform with the broad end upwards, but they seldom attain to the size of a vaginal hydrocele; they are fluctuant and transparent. The testis should always be made out, and will be found below and never behind the swelling. The tumour cannot be separated from the testis; all movements of one are followed by the other. Puncture with a fine trocar, and a chemical and microscopical examination of the fluid settles the question at once.

Treatment.—These cysts may exist for many years without encumbrance, and no treatment may be indicated. Simple puncture and emptying will often suffice if anything has to be done; but if more radical measures are called for, excision of the cysts should be preferred to the less certain and more troublesome method by injection of fluid irritants. The cyst must be fully exposed through a free incision in the scrotum, and its capsule freed as far as possible by careful dissection, so as to enucleate it from its bed without opening it; if the sac is opened its walls must be stripped away from their connections, taking care not to damage the testis or the epididymis. All bleeding points in the scrotal tissues must be secured, the wound closed with deep sutures, and dry aseptic dressings applied; the whole being well supported by a triangular bandage.

Encysted Hydrocele of the Testis (proper).—This rare form of tumour is situated between the tunica albuginea and the inner layer of the tunica vaginalis, or in the substance of the tunica albuginea itself. The cysts are usually single, of small size, and situated nearly always on the anterior surface of the testis. It is probable that they originate in small hæmorrhages which have become encapsulated. They may be recognised as very slowly forming small round tense swellings on the surface of an otherwise healthy testicle, and seldom call for treatment.

Complications of Hydrocele.—A hydrocele may be complicated (1) by the coexistence of one or more hydroceles, or (2) by the presence of a hernia.

(1) *Multiple Hydroceles.*—The combination

most frequently met with is that of ordinary vaginal hydrocele and encysted hydrocele of the epididymis. It is probable that the encysted hydrocele is formed first, and that owing to the irritation which its presence produces, effusions of fluid take place secondarily into the cavity of the tunica vaginalis. When the latter collection has attained a large size the presence of an encysted hydrocele may easily be overlooked. In such cases when the vaginal hydrocele is tapped, the usual pale yellow fluid escapes, and the swelling though diminished is not removed. If then the trocar be thrust onwards into the remaining swellings the characteristic watery or opalescent fluid of encysted hydrocele escapes. Another combination is that of encysted hydrocele of the cord with vaginal hydrocele.

(2) *Combination of Hydrocele and Hernia.*—A large hydrocele predisposes to hernia, and the usual combination is that of vaginal hydrocele with inguinal or scrotal hernia. The two swellings can usually be distinguished if attention be paid separately to their chief determining points. Encysted hydrocele of the cord is occasionally complicated with inguinal hernia. The treatment of these conditions by tappings and trusses must be carried out in the usual way. If radical measures are called for, some open method of operation—according to the individual features of each case—is the safest procedure.

Impotence.—By impotence is meant the incapacity for coitus. The causes are best divided into two heads: those which are physical and often permanent, and those which are psychical,—these latter being often temporary, frequently exaggerated, and sometimes imaginary altogether. The causes of impotence in the male are many and various. Firstly, congenital or acquired defects and deformities of the penis and testes, such as extreme conditions of hypospadias and epispadias; absence of penis; twists, and curvatures of the penis; or a persisting infantile condition of the genital organs or excessive size of the penis. Secondly, impotence may be acquired in the course of several diseases; thus it may arise from mere mechanical obstruction offered by the size of large scrotal hernias or hydroceles, in which the body of the penis is buried in the protuberance of the tumour. The same result is also seen in some cases of elephantiasis of the scrotum and penis. It may result from loss of the power of erection, which may be due to excessive sexual indulgence or prolonged masturbation; and further occurs as a natural symptom and feature in certain acute and chronic diseases, such as diabetes and albuminuria; and in injuries of the brain and spinal cord, such as contusion of the brain and fracture of the spinal column. Thirdly, impotence is brought about by the prolonged use of certain drugs, such as the bromides, iodides, opium, conium, camphor, arsenic, lead, and the abuse of alcoholic liquors. Fourthly, many cases arise from psychical causes, in which impotence is due to some mental disturbance, or to some deficiency of mental power.

Treatment varies with the cause, the removal of which is obviously the key to the cure. The last-mentioned type must be dealt with on common-sense lines; forced efforts at intercourse must be avoided, and sexual matters must be allowed to take their own course.

Sterility.—Sterility is the condition of inability to impregnate, and must not be confounded with impotence or the incapacity for sexual intercourse. The two conditions are distinct, though they may coexist. The causes of sterility in the male are chiefly these: 1. Malposition or retention of the testis. It has been already mentioned that nearly all such testes are atrophic and sterile. 2. Obstructions in the vas deferens and epididymis when bilateral. Congenital strictures in, or absence of these parts occasionally occur; but in the great majority the *obstructions* are acquired, and are residua of the acute epididymitis of gonorrhœa or the chronic epididymitis of tubercle. Injury to the vas or epididymis sometimes occludes their canals. 3. Obstructions, strictures, or fistulæ in connection with the prepuce, urethra, ejaculatory ducts, seminal vesicles, and prostate. The pin-hole preputial meatus has many times given rise to sterility which has disappeared after circumcision. Strictures of the urethra in any part of its course may become tightly closed during erection, the seminal fluid regurgitating into the bladder, and being discharged subsequently with the urine. The ejaculatory ducts have become permanently occluded after the operation of lateral perineal lithotomy. Fistulæ in connection with the urethra, seminal vesicles, or prostate may allow of the escape of the seminal fluid through adventitious channels, and so make impregnation impossible.

Another condition exists, and has been called aspermatism, in which a man who has sexual desires and erection finds that the act of coitus, however prolonged, is never satisfactorily completed by an ejaculation of semen, though this, accompanied by the usual orgasm, may take place at other times.

The treatment of sterility consists in ascertaining the cause of the condition, and treating it on general lines so far as it is capable of being treated.

Scruple or Scrupulus.—A weight of 20 grains; one-third of a drachm. *See* Prescribing (*Weights and Measures*).

Scultetus Bandage.—A bandage for compound fractures (devised by Scultetus,

1595-1645); it is made up of short pieces which can be removed without moving the fractured limb. *See* Bandages (*Many-tailed*).

Scurf.—The bran-like desquamation of the epidermis, or dandruff. *See* Eczema (*Mycosiform, Pityriasis Capitis*); Skin, Diseases of Sweat and Sebaceous Glands (*Seborrhœa, Dry*).

Scurvy.

Infantile Scurvy

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See also Colon, Diseases of (*Hæmorrhagic Ulceration in Scurvy*); Fragilitas Ossium; Hæmaturia (*Complication of Scurvy*); Hæmophilia (*Diagnosis*); Lungs, Gangrene of (*Etiology, Predisposing Causes*); Meninges of the Cerebrum (*Vascular Disturbances, Etiology*); Nails, Affections of the (*General Diseases, Subungual Hæmorrhages*); Retina and Optic Nerve (*Hæmorrhages in Retina, Causes*); Rickets (*Complications*).

Synonyms:—*Scurvy Rickets, Barlow's Disease—the Möller-Barlow Disease.*

1. Introductory.—Of those who have made a study of the disease which forms the subject of this article, some have looked upon it as a form of rickets, others as a variety of scurvy, and others again as a distinct morbid entity. These several opinions are reflected in its nomenclature. Thus Möller of Königsberg, who first described such cases (in 1859 and 1862), used the term "acute rickets," which was adopted by other Continental physicians who afterwards wrote upon the subject, among whom were Bohn, Förster, and Hirschsprung. On the other hand, in 1873, similar cases were recorded by Ingerslev in Denmark and Jalland in London, as examples of scurvy in infants, and in 1878 this view was independently taken up by Dr. Cheadle in a paper which, with his later writing upon the subject, must always rank among the most valuable contributions to its study.

In one of Möller's cases the exophthalmos present during life was shown post-mortem to have been due to hæmorrhage beneath the orbital periosteum, but the similar hæmorrhages about the long bones were first demonstrated in a case recorded by Sir Thomas Smith in 1876. In 1883 Sir Thomas Barlow placed our knowledge of the disease upon a firm basis, in a classical paper in which the clinical features were confronted with the lesions found after death in a series of cases; and the best testimony to the value of this contribution is the fact that on the Continent infantile scurvy is now usually spoken of as Barlow's disease. Like Dr. Cheadle, he adopted the scorbutic view, and looked upon the rachitic changes so usually present as constituting a variable and not an essential element.

Since that time papers too numerous for mention have been written upon the subject, both in this country and abroad. An elaborate collective investigation has been carried out in the United States under the auspices of the American Pediatric Society, and the recent researches of Naegeli and of Schoedel and Nauwerk upon the microscopical changes in the affected bones may be referred to as supplying new facts regarding a feature of the malady which had previously attracted but little attention.

2. Clinical Features.—Infantile scurvy is usually met with in children between the ages of six and eighteen months, most often before the completion of the first year of life.

Its most conspicuous and characteristic symptoms, upon which the diagnosis rests, are:—General tenderness and pain on movement, with resulting pseudo-paralysis, affection of the gums, and the development of swellings upon the long bones and elsewhere, which are due to subperiosteal hæmorrhages. These phenomena vary widely in their relative prominence in different cases.

Tenderness is often the earliest symptom, and there are good grounds for the belief that, as Dr. Cheadle suggests, one is sometimes justified in forming the diagnosis of infantile scurvy from this symptom alone—certainly such tenderness when standing alone is sometimes rapidly removed by antiscorbutic treatment.

The infant is fretful, cries when it is handled or moved, and often cries when any one approaches its cot, from mere apprehension lest it should be moved. Washing and dressing obviously cause severe pain.

As a result of the painfulness of any movement, the limbs, and especially the lower limbs, which are chiefly affected, are apt to be held motionless. In the slighter cases the legs are held drawn up, but in more severe ones they lie flaccid and everted, as if completely paralysed. Indeed the account given by the mother is often that the child has lost the use of its limbs, as also in cases of syphilitic epiphysitis, in which a similar tenderness is usually a prominent feature.

The affection of the gums, too, is usually an early developed sign. It varies greatly in degree, and must not be regarded as affording an index of the severity of the disease. It is greatly dependent upon the progress of dentition, and in children who have cut no teeth may be altogether wanting, even when the swellings of the limbs are well developed. However, even in toothless infants the gums often show a purple discoloration over the oncoming incisors; and when teeth have been cut, the swelling and

discoloration of the gums is usually confined to their immediate neighbourhood. Later on the gums may be much swollen so as to hide the teeth, raw, of a deep purple colour, and may bleed on the slightest provocation. In the worst cases of all they form fleshy excrescences protruding between the lips, and the breath may have an intense fœtor.

The fact that the gums may appear healthy in scorbutic infants who have no teeth is important in connection with diagnosis; for one occasionally meets with cases in which subperiosteal hæmorrhages are present, in association with general tenderness, but in which the confirmatory evidence which the gums usually afford is wholly wanting. It is more common to meet with mild cases in which tenderness and some degree of gum affection are the only scorbutic symptoms.

Subperiosteal hæmorrhages are most commonly met with in the lower limbs, and especially near the lower epiphysis of the tibia. How comparatively seldom the arms are affected is well shown by the American statistics, which include 131 cases with swellings in the legs, as against only 14 in which they were present in the arms. However, I have seen a case in which the only swelling was around one humerus, and in which the gums appeared natural, there being no teeth. Here the diagnosis of infantile scurvy was confirmed by the rapid disappearance of the general tenderness and local swelling under antiscorbutic treatment.

The size and characters of the swellings are not simply dependent upon the amount of blood effused beneath the periosteum, but also upon serous exudation and hæmorrhage into the muscles. There may be merely slight thickening around the bones, only to be made out on palpation, or the entire thigh or leg may be intensely swollen, and the skin covering it tightly stretched and shiny. The colour of the skin is usually natural, and there is an absence of any sensation of local heat. There may be œdema, especially of the dorsum of the foot. Occasionally, in severe cases, a soft crepitus bears witness to a fracture having occurred in the immediate neighbourhood of an epiphysis.

The joints are not implicated, and the swelling, which tends to be fusiform, ceases at the junction of the shaft of the bone with the epiphyses.

These swellings are not confined to the bones of the limbs, but may be met with in other situations, as upon the ribs, clavicles, scapulæ, and even upon the cranial bones. One special variety calls for mention, namely, hæmorrhage beneath the periosteum of the orbit, which gives rise to exophthalmos, usually unilateral and suddenly developed, sometimes during a fit of crying. With the exophthalmos there is, as a rule, some swelling and discoloration of the eyelid, and corneal ulceration may occur in severe cases.

As has been mentioned, one of Möller's cases showed this, and that it is no very exceptional event is evidenced by the American statistics, wherein swelling or protrusion of the eyeball is mentioned as having been observed in 49 out of a total of 379 cases, and was expressly stated to have been absent in 110. In 18 cases protrusion only was mentioned, in 9 cases swelling only, and in the remaining 22 both swelling and protrusion. Cases have been described by Mr. Holmes Spicer in which such eye phenomena were practically the only symptoms present, but which yielded to antiscorbutic treatment.

Sir Thomas Barlow has directed attention to a very marked depression of the sternum *en bloc* which is apt to be present in severe cases of infantile scurvy, and which, in its extreme form at any rate, is due to separation at the costo-chondral junctions. Weakness of the back is another not uncommon symptom.

Cutaneous hæmorrhages, either petechiæ or vibices, are not uncommon, and bruising may follow trifling injuries. Of the mucous membranes, that of the gums is by far the commonest seat of bleeding, but blood may be passed in the motions, or epistaxis may occur. Of the American cases, hæmorrhages from mucous membranes (excluding hæmaturia) were reported as absent in 196, and as occurring in 164. In no less than 93 of these the bleeding was from the gums, in 33 from the nose, from the stomach in 2, and from the bowel in 37.

Hæmaturia is not uncommon, and may be a very early, or even the only symptom of the scorbutic state, as has been pointed out by Drs. Gee and John Thomson. It occurred in three successive cases recently under the writer's care. Its occurrence affords no evidence of special severity of the disease. Albuminuria may persist after the blood has disappeared from the urine, and there may be albuminuria apart from hæmaturia.

Although in the milder cases there may be no conspicuous anæmia, in severe ones it is usually very pronounced, and especially in those in which there have been extensive subperiosteal hæmorrhages, and here there is usually a cachectic earthy tint of the skin. I am indebted to Dr. H. Thursfield for a summary of the results of a series of blood examinations which he has made. The changes observed were in no way characteristic, but resembled those met with in cases of ordinary rickets, viz. a marked deficiency of hæmoglobin and a much less conspicuous diminution in the number of red corpuscles. The colour-index, in a number of cases, averaged 0·5. In very severe cases with subperiosteal and other hæmorrhages, nucleated red corpuscles were seen and occasionally some poikilocytosis. In the absence of complication the leucocytes are not increased in number, nor is the ratio of the several

varieties disturbed ; but where severe hæmorrhage has occurred, a slight leucocytosis is observed, the increase being confined to the lymphocytes. The following figures were obtained in a case of moderate severity in a child one year old :—

Hæmoglobin, 34%.
Red corpuscles, 3,040,000.
Leucocytes, 11,000.
Including { Polymorphonuclear leucocytes, 64%. Lymphocytes, 31%. Large mononuclear, 5%.

As a rule scorbutic infants are not wasted, but their muscles are usually soft and flabby. Some evidence of rickets is almost always present, such as beading of the ribs, gaping fontanelle, or delayed dentition. However, the clinical signs of rickets are occasionally entirely wanting, and it is exceptional to meet with rachitic changes of a severe degree in such infants.

Fever is no essential feature of infantile scurvy, and the milder cases often run a practically afebrile course. When, however, subperiosteal hæmorrhages occur, there is apt to be a rise of temperature to 101° or 102°. Fever may also result from the development of complications such as broncho-pneumonia.

The diagnosis of infantile scurvy seldom presents any great difficulty to those who are acquainted with the ordinary features of the disease. It is chiefly in cases in which the gum affection is absent that any difficulty arises, or in those in which one of the less common manifestations, such as exophthalmos or hæmaturia, is the earliest conspicuous sign. The gum affection may be set down to an ordinary stomatitis, and the swellings of the limbs have not infrequently been mistaken for sarcomata or for abscesses in connection with acute osteo-myelitis, and incisions have sometimes been made into them, which have only revealed the presence of blood-clot.

As has been mentioned, a similar tenderness and pseudo-paralysis may accompany syphilitic epiphysitis.

The prognosis is very favourable in the milder cases, provided that the disease is recognised and the correct treatment is initiated. Under such circumstances recovery is usually rapid and complete, nor is recovery unknown even apart from any obvious change in the diet. The absorption of extensive subperiosteal hæmorrhages is, however, naturally a matter of some time, especially if a sheath of bone has been formed beneath the separated periosteum. Of the effect upon the later development of the limbs in cases in which fractures have occurred near the epiphyses, I have no evidence to offer. In severe cases, with extensive hæmorrhages, in infants who are extremely anæmic, and whose skin has an earthy cachectic hue, even the most careful treatment may fail to bring about any improvement, or to avert a fatal ending, which may be hastened by bronchitis, broncho-pneumonia, diarrhœa, or some other intercurrent disorder.

Nowadays the disease, when once recognised, is not allowed to run its natural course, but on the basis of the early cases Sir Thomas Barlow places its average duration, when untreated, at between two and four months. In some of the early cases relapses occurred after complete or partial recovery, and in cases in which recovery has followed a change of diet, relapses may naturally occur if the previous vicious system of feeding is reverted to.

3. Morbid Anatomy.—Of the changes observed *post mortem* in infants who have succumbed to infantile scurvy, the chief pathological interest centres around the lesions in the bones and in the structures around them. The superficial muscles of the limbs which have been the seats of conspicuous swellings during life are pale, and present a sodden appearance as the result of serous infiltration, whilst in the deeper muscular layers considerable extravasations of blood may be met with. The periosteum of the affected bone is found to be thick and highly vascular, but shows no evidences of actual inflammation ; and it is separated from the underlying bone by a layer of blood-clot of greater or less thickness. The extravasation may be confined to one end of the bone or may cover the entire diaphysis, whilst in extreme cases the epiphyses may be found broken off, leaving the diaphysis completely embedded in a mass of blood-clot, enclosed in a bag of periosteum. The clot varies in colour according to its age, and may show a laminated structure suggestive of a series of distinct hæmorrhages. In cases of long standing it may be almost completely decolorised and organised, and may be ensheathed by a thin bony lamina formed beneath the separated periosteum.

Hæmorrhages also occur into the bone itself, especially in the neighbourhood of the epiphyses, where also a rarefaction of the cancellous structure is noticeable. The weakening of the bone in this region probably has an important share in determining the occurrence of fractures, for the separation of the epiphyses so often observed is usually due to actual fracture of the shaft at a short distance from the epiphyseal line. However, in some instances there is a true separation or lateral displacement of an epiphysis. Hæmorrhages may also occur in the ossifying centres of the epiphyses.

The rarefaction of the bones above referred to was noticed by Sir Thomas Barlow, who in one of his cases found the ribs reduced to mere thin bony shells, and formed a conspicuous feature in the bones which were submitted to microscopic examination by Angel Money, Naegeli, and Schoedel and Nauwerk. The German investigators described a conspicuous diminution

of the lymphoid cells of the medulla, which consists in the main of connective tissue elements and blood-vessels. In the cancellous tissue the trabeculæ are scanty, and the number of osteoblasts are markedly below the normal. The denser portions of the bone structure are also affected.

Schoedel and Nauwerk attribute the rarefaction of the bone to deficient formation rather than to the absorption of bone previously formed. They base this opinion upon the fact that Howship's lacunæ are not increased in number, that the osteoblasts are scanty or even absent, and that there is a diminution rather than an increase of osteoblasts. They are, moreover, inclined to connect the defective bone formation with the abnormal condition of the bone-marrow above referred to.

The rarefaction has been ascribed to the intraosseous extravasations, but Naegeli is inclined to look upon it as a primary and characteristic feature of the disease which precedes the occurrence of hæmorrhagic lesions.

The ordinary changes met with in the bones of rachitic infants are also present in the great majority of the cases.

Other hæmorrhagic lesions are also met with, but these are not characteristic of infantile scurvy. Blood-stained fluid may be present in serous cavities, and there may be hæmorrhages into the viscera as well as into the superficial structures.

Sutherland has observed subdural hæmorrhages in a case in which another exceptional feature was fracture of the femur near the middle of the shaft.

Lastly, there may also be present the lesions of intercurrent disorders such as bronchopneumonia.

4. Etiology and Pathogenesis.—Although infantile scurvy results from errors of diet, these errors are as a rule of a much less gross character than those met with in many cases of severe rickets. As a matter of fact the disease, at least in its milder forms, is more often met with among infants in favourable surroundings than amongst those of the class from which hospital patients are mostly drawn.

It has been pointed out by Dr. Cheadle and others, that the antiscorbutic properties of milk are not of a high order, and they are apt to be impaired or destroyed by the various modes of preparation so largely resorted to, such as condensation, peptonisation, and the prolonged heating required for effectual sterilisation. It will, indeed, be found that in most cases of infantile scurvy, milk prepared in one or other of these ways, or humanised milk, which has undergone sterilisation, has been the main article of the child's diet. There is, moreover, evidence to show that the mere raising of milk to the boiling-point is not wholly without a similar effect. Hence it is evident that excessive care, as distinguished from want of care, in the feeding of infants may induce the disease, and thus its comparative frequency among children of the well-to-do classes is readily explained.

However, of the infants brought up upon sterilised, humanised, or even condensed milk, only a small proportion develop scurvy, and it is probable that the risk of its occurrence is removed by the addition to the diet of some fresh element, such as raw-meat juice or the juice of oranges. On the other hand, the advantages of sterilisation of milk as a preventive measure are obvious, and provided that the reduction of its antiscorbutic properties is recognised and guarded against, the risk of scurvy need not be regarded as contra-indicating its use when fresh milk cannot be relied upon.

In cases in which fresh milk has been given, it has usually been only for a short period, and that some time previously, or the quantity may have been wholly inadequate, or the milk itself may have been of inferior quality. In some of the worst cases very little milk of any kind has been taken, and now and again one is confronted with infants whose diet has consisted entirely of a farinaceous food and water. It is in such cases that infantile scurvy is met with in its most severe forms, and it is probably by replacing milk, either wholly or in part, that the proprietary foods which often figure so largely in the dietary of scorbutic children conduce to the development of the disease, seeing that they are themselves devoid of antiscorbutic properties. However, Holt mentions two cases which have come under his observation in which scurvy developed in infants taking sterilised milk and a proprietary food, who recovered when the food was stopped, although the heating of the milk was continued. In some instances the history forthcoming appears to be at variance with what has been stated above, the dietary showing no conspicuous error. Nevertheless the scorbutic lesions present are unmistakable, and that the diet is actually at fault is shown by the rapid improvement which sets in as soon as a change is made. Thus in a case in which in addition to subperiosteal swellings there was severe affection of the gums, the infant was at first given fresh milk and water in the proportion of 1 to 3. After three months it had milk and barley water in equal parts, and from six months onwards a malted food with fresh cow's milk. The milk, for which an adequate price was paid, was just raised to the boiling-point, and from the age of six months the amount taken daily was about a pint and a half. Nevertheless, under the ordinary antiscorbutic treatment, the improvement was rapid, and recovery was ultimately complete.

Such cases, like those mentioned by Holt, seem to support the view that errors of diet which cause scurvy may be positive rather than negative, the presence of deleterious ingredients

rather than the absence of antiscorbutic ones (*see* article "Scurvy in Adults," p. 113); but if this be the case, the mere addition of fresh elements, without change of diet, should fail to cure the disease. How far it does so is a point which calls for further investigation.

Cases have even been recorded occurring in breast-fed infants, but they are certainly very rare, and in most of them, at any rate, some special circumstances have been present, such as inadequate supply of milk, or impaired health of the nursing mother. The view here adopted, that the disease under consideration is identical in its nature with the scurvy of adults, whatever the pathology of the latter may be, has met with general acceptance in this country and in the United States, as is evidenced by the names in ordinary use for it. On the Continent, on the other hand, this is not the case, and the great majority of Continental observers hold either that it is not scorbutic in its nature, or at least that its identity with adult scurvy is non-proven; and this is why the name of Barlow's disease, which makes no such assumption as to its nature, has found such wide acceptance among them.

No argument adduced in support of the scorbutic theory approaches in cogency that based upon the curative effect of a diet containing fresh elements, such as unboiled milk, orange juice, or raw-meat juice. Although in the most severe cases such a diet is not capable of averting a fatal ending, the effect in milder cases is most striking, and a rapid and continuous improvement under appropriate feeding may be confidently predicted. So uniform, indeed, are the results, that one cannot help regarding with suspicion cases of a less severe kind, diagnosed as examples of infantile scurvy, in which such treatment is without effect.

It has been observed that improvement and even recovery may occur apart from any deliberate change of diet, but there is little doubt that a slight change in the conditions, such as a change of milk-supply, may turn the scale in one or other direction.

The character of the gum affection and its distribution about such teeth as are present, as also the tendency to hæmorrhages in various situations, agree with what is seen in adult scurvy.

Those who reject the scorbutic theory are not prepared to take so favourable a view of the effects of antiscorbutic treatment, but the strongest argument which they adduce is based upon the special and very characteristic tendency to subperiosteal hæmorrhages in the infantile disease, lesions which, although not unknown in the scurvy of adults, are certainly not of common occurrence.

It has also been objected that in countries, such as Russia, in which adult scurvy is not uncommon, the infantile affection appears to be very rare, and that in outbreaks of true scurvy, infants show little liability to suffer.

In answer to the first objection, it is urged that the special liability to subperiosteal hæmorrhage may be due to the age of the patients, and to the vascularity of the tissues, which are in a condition of specially active growth. As to the immunity of infants during so-called epidemics of scurvy, further evidence is to be desired.

The opponents of the scorbutic view have no satisfactory alternative to offer in its place. For the suggested infective origin of the malady no tangible evidence is forthcoming, and the view that we are here dealing with a hæmorrhagic diathesis associated with rickets does not take us appreciably further, especially in view of the fact that cases are met with in which clinical evidences of rickets are wholly wanting.

5. Treatment.—It is impossible to discuss the clinical features and etiology of infantile scurvy without dealing at the same time with the subject of its treatment, and the importance of introducing what Sir Thomas Barlow speaks of as "living" ingredients into the diet. It therefore only remains to give in this final section some details of the dietary which brings about the best results in these cases.

Fresh milk should be substituted for any form of prepared milk hitherto given, and if the supply can safely be trusted, there is little doubt that unboiled is to be preferred to boiled milk as the staple food of these patients. However, in view of the limited antiscorbutic properties even of unboiled milk, it is always well to add other fresh elements to the diet, such as raw-meat juice or orange juice or potato cream. The only objection to raw-meat juice is the risk of introducing the ova of tapeworms into the alimentary canal, but this risk can be to a large extent avoided by straining through fine muslin—a precaution which it is always well to take.

It is prepared by extracting fresh, uncooked meat, such as best rump steak, with a small quantity of water. Some two ounces of raw meat are scraped into a pulp, to which half an ounce of cold water is added. After standing for an hour, the juice is expressed through fine muslin, and a teaspoonful may be added to the infant's bottle.

The juice of oranges is readily obtained and palatable. It may be given in a teaspoon, and may be sweetened if necessary. When oranges cannot be got, the juices of other fruits, such as grapes or lemons, may be used instead, and for children above a year old, well-baked apple may be given in suitable quantity.

Potato cream, which is highly recommended as a potent antiscorbutic remedy, is prepared by passing thoroughly steamed potatoes through a fine sieve, and intimately mixing the fine powdery material so obtained with milk, until

the mixture has the consistence of cream. This may be added to the contents of the bottle in doses of a teaspoonful, which may be gradually increased to as much as a tablespoonful in the case of older children.

Hygienic measures, such as fresh air, are useful adjuncts to the dietetic treatment. Drugs are of no material service in the treatment of the scorbutic condition, but in the period of convalescence the administration of such drugs as cod-liver oil and iron may be indicated for the treatment of the rickets and anæmia so usually present. The liability to hæmorrhages and to fractures near the epiphyses, as also the extreme general tenderness, call for great care in handling scorbutic infants.

The clothing should be so constructed that the contortions ordinarily entailed in putting it on and off may be entirely avoided; but the child should be warmly covered, and when it is necessary to move it, it should be carried upon a soft pillow.

Under such treatment improvement is rapid and ultimate recovery complete, provided that the disease has not reached a stage at which recovery is no longer to be looked for. The general tenderness quickly disappears, the condition of the gums improves from day to day, and even the swellings of the limbs subside with a rapidity which is surprising, considering the nature of the lesions. On the other hand, the absorption of massive subperiosteal clots naturally takes time, and it may be months before the natural contour of the affected bones is restored.

Scurvy in Adults

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See also SCURVY, INFANTILE, and *Cross References.*

INTRODUCTORY. — This disease, which was formerly the most serious scourge of the navy and the mercantile marine, and was the cause of no small mortality among troops on active service, is now chiefly of historical interest; but it is still occasionally met with, and there is no reason to doubt that it would reappear with all its former malignity in any community in which the conditions which gave rise to it should from any cause come into existence again. The last severe outbreak of scurvy in the British navy was in 1795, when it seriously endangered the safety of Lord Howe's fleet. After this, on the advice of Sir Gilbert Blane, lime-juice was introduced into the navy; and it gradually found its way into the mercantile marine, its adoption being made compulsory by Act of Parliament in the year 1867. During the last hundred years the frequency of scurvy has gradually diminished, so that it has become one of the rarest of diseases. Thus during the five years ending 1868 the cases of scurvy admitted to the Seamen's Hospital at Greenwich were on an average 85 per annum, with an average of two deaths, while for the five years ending 1898 the average annual admissions amounted to only 1·4, and there has been no fatal case since 1887. The records of other large hospitals in seaport towns confirm this conclusion. Thus out of a total of 3089 patients admitted to the men's wards of the Liverpool Royal Infirmary during the last five years of the century which has just closed only two are stated to have had scurvy. This remarkable improvement, which may be not inappropriately compared with the diminution of smallpox which followed the discovery of vaccination, has by most authorities been attributed to the introduction of lime-juice on board ship; but the general introduction of steam enabling fresh supplies of food to be more frequently obtained, the adoption of better methods of preserving food, and the prevalence of improved hygienic conditions on board ship must be credited with a considerable share of the amelioration which has taken place. The fuller consideration of this point, however, had best be deferred to the section dealing with the etiology and prophylaxis of the disease.

CLINICAL FEATURES.—The symptoms of scurvy may best be considered under two heads, viz. those associated with anæmia and general malnutrition, and those associated with a tendency to ecchymoses and spontaneous hæmorrhages. The onset is generally slow and insidious, the symptoms being those of progressive cachexia and anæmia. The complexion is sallow and dull, and of a leaden hue, reminding one of the appearance of the subject of frequent attacks of malaria; the epidermis is dry and tends to desquamate, the conjunctiva is pearly white, there is extreme physical weakness and mental apathy, together with shortness of breath and pains in the back and lower limbs. As the disease advances the more characteristic signs of scurvy appear. The gums become swollen and livid, they tend to bleed and ulcerate, and may actually slough. This affection of the gums, though generally present, is not constant; it begins between the teeth, is especially severe in the neighbourhood of carious teeth and stumps, and is reduced to a minimum in the case of edentulous subjects. The teeth, buried in the swollen and bleeding gums, become loose and may drop out, and mastication is painful and may become impossible. The other characteristic sign of scurvy is the occurrence of hæmorrhages from the mucous membranes, or into the substance of the skin, the subcutaneous cellular tissue, or the deeper structures of the body.

Ecchymoses of various extent appear, chiefly on the lower limbs, which present a bruised appearance, especially evident in the region of the knees; and brawny indurations, often painful and tender, arise in the hams and calves, and may be so dense and abundant as to fix the limbs in a semiflexed position. Node-like swellings are often observed over the tibia, owing to effusion between the periosteum and the bone. The breath has a peculiar offensive odour, which may be aggravated by sloughing of the gums, or even necrosis of the jaw; the bowels are constipated, but the appetite is maintained, and there is no thirst.

Scurvy is less frequently met with in an uncomplicated form than in association with other diseased conditions. The most frequent complications are probably dysentery, malaria, and syphilis. Probably some of the symptoms which the older physicians attributed to scurvy were really due to complicating diseases, but owing to the infrequency of scurvy since the more searching methods of modern diagnosis have become general it is difficult to speak positively on this point. The tissues seem to lose their normal reparative powers, ulcers will not heal, fractures will not unite, and old scars may break down, and even fractures which have healed may become disunited.

Morbid Anatomy.—As might be inferred from what has been said of the infrequency of scurvy in recent times, it does not appear that any searching investigations have been made into its pathological anatomy since the more modern methods of histological research have come into use. The obvious naked-eye appearances are such as might be expected from what we know of the clinical features of the disease. Decomposition sets in rapidly, ecchymoses observed during life persist after death, and are speedily merged in post-mortem staining, and blood-stained serum, or actual effusions of blood, are formed in the subcutaneous areolar tissue. The brawny swellings observed during life are found to consist of firm clots of blood, more or less decolorised and organised according to their age. These hæmorrhagic effusions may be numerous and of various extent, and may occur either in the substance of the muscles or outside their sheaths. Similar effusions may be found under the periosteum or in the substance of the bones, and there may be large serous effusions, more or less stained with blood, in the great serous cavities of the body. No satisfactory explanation of the hæmorrhagic tendency so characteristic of the disease has been offered; investigations carried out more especially with regard to the blood-vessels seem to show that they are free from morbid change. Various lesions have been described in connection with the viscera, but there was nothing distinctive about them, and they were probably due to some associated morbid conditions.

Diagnosis.—The diagnosis of scurvy in the adult can only present difficulties when it arises under unusual circumstances, in which the existence of the dietetic antecedents is not obvious, or when, as has been known to happen, it comes on insidiously in the course of some other disease. The presence of tender gums and subcutaneous ecchymoses should at once arouse the suspicions of the physician, and the disappearance of the symptoms when the diet has been changed will speedily confirm them.

Prognosis.—The prognosis in uncomplicated scurvy is always favourable provided the appropriate treatment can be carried out at once, but in severe cases it is necessary to guard against any sudden exertion on the part of the patient, the assumption of the erect posture having been known to induce a fatal syncope.

Treatment.—The treatment is almost purely dietetic, but in the cases of severe exhaustion, which are now seldom seen, the greatest care must be taken to avoid syncopal attacks, the patient being forbidden to exert himself in any way or even to sit up in bed. Fresh food, animal and vegetable, must be administered in small quantities and at frequent intervals. In uncomplicated cases recovery is uninterrupted and complete, but the presence of complications, more especially of dysentery, may call for the exercise of much care and judgment in the management of the patient.

Etiology and Prophylaxis.—For more than a century the opinion has been all but universally held that the essential cause of scurvy is the absence of fresh vegetables from the diet, and much ingenuity has been spent in the endeavour to ascertain what is the special constitutent of fresh vegetable food the want of which gives rise to this disease. The freedom from scurvy enjoyed by children and others who live chiefly or exclusively on fresh milk or fresh animal food makes this view quite untenable, but if for absence of fresh vegetables we substitute absence of fresh organic food, whether animal or vegetable, there is much to be said for it.

On the other hand, it has lately been maintained with much show of plausibility, especially by Mr. F. G. Jackson and Mr. Vaughan Harley, that scurvy is not a deprivation disease, but a toxæmia arising from the ingestion of decomposing food.

That the withholding of vegetable food is by itself incapable of causing scurvy is shown by the immunity enjoyed by those tribes who are unable to obtain vegetable food in any form, by the immunity enjoyed by children and others who subsist for long periods on fresh milk alone, and more particularly by the experience of Arctic explorers, such as Nansen and Johansen, who subsisted for nine months on walrus and bear flesh preserved only by the cold. On the other hand, there are plausible grounds for the

view that scurvy can be induced by a diet from which all kinds of fresh food are excluded. Thus it has been asserted that sterilisation or prolonged boiling of milk destroys its anti-scorbutic properties, and nearly all cases of scurvy in children can be traced to prolonged feeding on sterilised milk or foods that have been doctored in some way (*see* article "Scurvy, Infantile," p. 108).

The view that the symptoms of scurvy are due, not to deprivation of fresh food, but to absorption of ptomaines from decomposing meat, seems to be indicated by the fact that the ingestion of a regular supply of lime-juice has in certain cases failed to keep off scurvy when preserved meat formed the principal article of diet, and it receives some support from the experiments of Jackson and Harley, who observed symptoms closely resembling human scurvy in monkeys fed on meat which was partially decomposed. With regard, however, to the first consideration, viz. the appearance of scurvy in persons who were taking lime-juice, an event which must be of exceedingly rare occurrence, it is possible that the lime-juice shared the drawback of the other preserved food, and had lost its antiscorbutic properties. With regard to the experiments on monkeys, it must be borne in mind that the symptoms were by no means identical with those of human scurvy, and that we must be exceedingly cautious in inferring from the results of giving putrid meat to vegetarian monkeys, the effects which similar feeding would have upon omnivorous man.

To sum up our present knowledge of the etiology of scurvy, we may say that it is liable to appear when the diet is composed chiefly or exclusively of food which has been kept a long time, or has been subjected to profound physical or chemical changes; but whether this effect is due to the disappearance of certain so-called antiscorbutic properties, or to the development of toxic products of decomposition, the evidence at hand is insufficient to enable us to decide.

Scurvy, Land. *See* Purpura.

Scurvy Rickets. *See* Scurvy, Infantile.

Scutch.—The residue of the hides, hoofs, horns, bones, etc., after the liquid glue has been run off (in glue-making); it is used for manure.

Scutula.—The shield-shaped (Lat. *scutum*, a shield) crust left on the skin when a vesicle bursts and dries up. *See* Favus (*Clinical Features, Scutula*).

Scybalum.—A hard mass (rounded or irregular) of constipated fæces (plural, *scybala*); it is derived from Gr. σκύβαλον, dung. *See* Constipation (*Symptoms*).

Scythian Disease.—A disease characterised by atrophy of the male genital organs and the development of feminine attributes; a form of sexual perversion or effeminacy.

Scytoblastema.—The skin in the embryonic stage (Gr. σκῦτος, hide, and βλάστημα, a bud).

Sea Coast. *See* Lung, Tuberculosis (*Treatment, Climate, Sea Coast*).

Sea Kale.—A vegetable (*Crambe maritima*) used in invalid feeding. *See* Invalid Feeding (*Vegetables*).

Sea Sickness. *See also* Hypnotism (*Uses*).—A form of nausea, often accompanied by vomiting, induced by movement on the sea. The nausea and vomiting in this affection have nothing to distinguish them from the same symptoms in some other affections; their leading characteristic is the causation. The same train of symptoms may be induced by movement in a train, omnibus, or the like. While the peculiar movement on the water is mainly responsible for the condition, there are contributory factors. Of these we may mention sensations derived on board from the sense of smell, and also mental stimuli derived from the recollection of past experiences. The cause of sea sickness is quite obscure. It may be, as some suppose, that the epigastric region is the seat of an equilibrative centre, but if so the manner of working of such a centre is quite unknown. It is more likely that the epigastric sensations of discomfort are secondary to a disturbance in the cerebrum or medulla. On a long voyage the condition tends to spontaneous cure usually in from three to five days. The treatment of the disease is not very satisfactory. A great variety of remedies have been advocated, but only a very few of these have been found to be really serviceable. Mention may be made of cocaine, morphin, and phenacetin, either alone or in various combinations. Great care and discretion are necessary in the administration of these or other sedatives. Persons who are prone to sea sickness should pay particular attention to the state of the digestive tract for a few days before sailing. A light diet should be taken, and the bowels should be thoroughly cleaned out by small doses of calomel followed by a saline. When on board the circumstances should be disregarded as much as possible, the attention of the passenger being taken up in the pleasantest way possible. A good meal may be taken, with a little stimulant. If nausea set in notwithstanding these precautions, little or nothing can be done to alleviate the condition. If the voyage be a short one the symptoms will cease on the removal of the cause, and if the voyage be a long one the patient must look forward to a few days'

wretchedness before he acquires his sea legs. It should be mentioned, however, that a few cases are very persistent, the patients becoming seriously ill, and requiring careful nursing and feeding, for days or longer, with iced stimulants.

Sea Tangle. *See* Laminaria Tents.

Sea Voyages. — The plea for a sea voyage in therapeutics is a more restricted one than was at one time in vogue. Cases of tuberculosis are now more suitably treated at home under the more healthy hygienic regime of the open-air methods of treatment. Cases of mental weakness, *e.g.* melancholia and the like, should not be treated by sending the patients on a sea voyage (see "Insanity, Treatment of," vol. iv.). In other diseases, when a sea voyage may be thought of, the utmost care should be taken to ensure (1) that the quality of the food should be of a kind favourable to the patient; (2) that the sleeping accommodation is all that is desirable; (3) that the prospects of the patient having the desired amount of rest and pleasure are fairly good.

Seaford. *See* Therapeutics, Health Resorts (*English*).

Seamen. *See* Colour Vision (*Practical Remarks, Seamen, Tests*).

Seasons. *See* Diphtheria (*Etiology*); Epidemiology; Malaria; Pneumonia, Clinical (*Predisposing Causes, Season*); Rheumatism, Acute (*Etiology, Predisposing Causes*).

Sea-Water Baths. *See* Balneology (*Marine Baths*).

Sebaceous. — Secreting or containing sebum, e.g. *sebaceous cysts* and *sebaceous glands*. *See* Neck, Region of (*Cysts and Cystic Tumours*); Physiology, Excretions (*Skin*); Skin, Anatomy and Physiology (*Sebaceous Glands*); Skin, Diseases of Sweat and Sebaceous Glands.

Sebolith. — A concretion or calculus formed in a sebaceous gland.

Seborrhœa. — A disease of the skin characterised by excessive secretion of sebum from the sebaceous glands, the secretion forming crusts or scales or an oily covering for the integument. *See* Skin, Diseases of Sweat and Sebaceous Glands (*Seborrhœa*). *See also* Alopecia (*Relation to Seborrhœa*); Eczema (*Clinical Types, Mycosiform or Seborrhœic Eczemas*); Lung, Tuberculosis of (*Complications, Integumentary System*); Psoriasis (*Diagnosis*); Skin, Bacteriology of (*Seborrhœa oleosa*); Skin, Parasites (*Tinea Tonsurans, Differential Diagnosis*); Warts (*Verrucæ Seniles* or *Seborrhœic Warts*).

Sebum.—The oily secretion of sebaceous glands. *See* Skin, Anatomy and Physiology (*Sebaceous Glands*).

Secale Cornutum. *See* Ergot.

Seclusion.—A method of treatment of insanity in which the patient is placed in a padded room; both this method and that by mechanical restraint (*e.g.* the strait-waistcoat) are now much less often employed. *See* Insanity, General Treatment of (*Restraint*).

Second Intention. *See* Wounds (*Repair, Healing by Granulation*).

Secondary.—Following upon the first of anything, e.g. *secondary action* (in Pharmacology), *secondary amputation, secondary contracture, secondary hœmorrhage, secondary syphilis*, etc.

Secretin.—A material which forms in the epithelium of the intestine under the action of an acid, which, being absorbed and carried in the circulation to the pancreas, causes it to secrete. *See* Physiology, Food and Digestion (*Pancreatic Secretion*).

Secretion. — The physiological act of forming from the blood a substance which either passes from the gland (in which it is elaborated) and is "thrown out upon the external or internal surface of the body," or is absorbed into the blood (*internal secretions* or *hormones*). *See* Physiology, Food and Digestion (*Pancreatic, Intestinal, and Hepatic Secretions*); Physiology, Internal Secretions or Hormones; Pancreas, Physiology of Pituitary Body; Puerperium, Physiology (*Lactation*); etc.

Sectio.—A section or dissection; e.g. *sectio abdominalis* (laparotomy), *sectio cadaveris* (a post-mortem examination or necropsy), *sectio cæsarea* (Cæsarean section), *sectio lateralis* (the lateral operation of lithotomy), etc.

Section.—The act of cutting or the material cut (*e.g.* microscopic sections). *See also* Sectio.

Secundines.—The placenta, membranes (chorion and amnion), and the umbilical cord, which are expelled after the birth of the child. *See* Labour, Stages and Duration (*Third Stage*); Labour, Management of (*Third Stage*).

Secundipara. — A woman who has borne two children, or who is going through her second confinement.

Secundum Artem. — Literally, "according to art," a term used in prescription-writing, and represented by the contraction S.A. or *sec. art.* *See* Prescribing (*Table I., Contractions*).

Sedatives.—Drugs having a soothing or sleep-producing effect, such as bromide of potassium, hydrobromic acid, chloroform, paraldehyde, chloral hydrate, sulphonal, and opium.

Segment.—A portion, part, or subdivision of anything; *e.g.* the anterior and posterior segments of the pelvic floor, the lower uterine segment, the cusps of the valves of the heart, etc.

Segmental.—Belonging to or made up of segments; an animal composed of a longitudinal series of similar segments (more or less modified to perform different functions) is said to be formed on the segmental type and to have serial homology.

Segmentation.—The division of the impregnated ovum into numerous cells, and the formation of the morula mass. *See* Fœtus and Ovum, Development of (*Segmentation*).

Segregation.—The separation of affected persons from the general community, as in cases of leprosy; partial isolation.

Segregator.—An instrument by means of which urine from each kidney can be separately obtained for analysis.

Seguin's Signal Symptom.—The initial convulsive movement or movements in epilepsy, indicating the beginning of an attack; it is specially noticed in Jacksonian epilepsy.

Seidlitz Powder.—Pulvis Sodæ Tartaratæ Effervescens. As obtained from the chemist the powder is in two parts: one, wrapped up in blue paper, consists of 120 grains of tartarated soda and 40 grains of bicarbonate of soda; while the other, in white paper, consists of 38 grains of tartaric acid. The powder in the blue paper is dissolved in nearly half a pint of water, that in the white paper is then added, and while effervescing is going on the mixture is drunk. Seidlitz powder acts as a mild purgative, and is taken commonly in the morning before breakfast.

Seidlitz Waters. *See* Balneology (*Austria, Bohemia*).

Seismotherapy.—The treatment of disease by mechanical vibration (Gr. σεισμός, a shaking or shock, θεράπεία, medical treatment).

Seleniasis.—Lunacy (Gr. σελήνη, the moon). *See* Insanity.

Self-Abuse. *See* Masturbation.

Self-Mutilation.—A symptom of insanity, the patient removing some part of the body (hand or genital organs), usually under the delusion that he is thereby obeying an injunction of religion. *See* Œdipism.

Sella Turcica.—The upper part of the body of the sphenoid bone, so called from its resemblance to a Turkish saddle; the pituitary body is lodged in it.

Seltzer Water. *See* Balneology (*Germany, Hesse-Nassau*).

Semeiography.—A description of symptoms; symptomatology; it is derived from the Greek σημεῖον, a mark or sign.

Semeiology.—Symptomatology or semeiotics (Gr. σημεῖον, a sign).

Semelincident.—Occurring once only in the same person, *e.g.* a semelincident disease is one which does not attack a patient twice.

Semen.—A seed, *e.g.* (in the plural) *semina physostigmatis, strophanthi semina, stramonii semina*, etc.; also, the impregnating fluid secreted principally by the testicles, and containing spermatozoa.

Semester.—A period of six months, half a year.

Semi-.—In compound words *semi-* (Lat. *semis*, half) means half, or partial, or incomplete; e.g. *semicanalis*, a groove or sulcus (literally, half a canal), *semicretinism* (the condition of being an incomplete cretin), *seminormal* (half the normal), etc.

Semicircular Canals. *See* Auditory Nerve and Labyrinth; Brain, Physiology of (*Nucleus of Deiters*); Physiology, Neuro-Muscular Mechanism (*Sense of Hearing, Internal Ear*); Vertigo (*Ménière's Disease*).

Semilunar.—Crescentic, shaped like a half-moon; *e.g.* the semilunar cartilages of the knee, the semilunar bone of the carpus, and semilunar ganglia, folds, lobes, notches, and valves. *See* Knee-Joint, Injuries of (*Dislocation of Semilunar Cartilages*); Heart, Congenital Malformations of (*Abnormalities of Semilunar Valves*); etc.

Semimembranosus.—The name of a muscle (partly membranous) at the back of the thigh.

Seminal Emissions. *See* Spermatorrhœa; Circumcision (*for Phymosis*); Medicine, Forensic (*Death from Asphyxia, Post mortem Appearances*).

Seminal Vesicles. *See* Vesiculæ Seminales.

Semiplegia.—Hemiplegia, or paralysis of one half of the body.

Semiprone.—Lying partly on the side, and partly on the face and chest; Sims' position. *See* Gynæcology, Diagnosis in.

Semis.—Half (Lat. *semis*, half); a term used in prescription-writing, when it is usually contracted into *ss*. *See* PRESCRIBING (*Contractions*).

Semispinalis.—The name of certain muscles which are attached partly to the vertebral column, e.g. *semispinalis colli*, *semispinalis dorsi*.

Semitendinosus.—A muscle of the back of the thigh.

Semivalent.—Of half the normal valency or combining capacity of an atom as compared with hydrogen.

Semolina. *See* DIET (*Vegetable Foods, Cereals*); INVALID FEEDING (*Convalescence, Semolina Pudding*).

Semon's Symptom.—Impaired mobility of the vocal cords of the larynx in cancer of that organ.

Sempstress' Cramp or Palsy.—An occupation-neurosis resembling writer's cramp. *See* NEUROSES, OCCUPATION.

Senator's Phlegmon. *See* PHARYNX, ACUTE PHARYNGITIS (*Symptoms*).

Senecio.—Groundsel (Nat. Ord. *Compositæ*). There are many species, of which some have been used as medicines; e.g. *Senecio vulgaris* (for scurvy), *Senecio doronicum* (in asthma), etc.

Senegæ Radix.—Senega, the dried root of *Polygala senega* (a North American plant), contains a glucoside (senegin) and polygalic acid, and is used in medicine as a stimulating expectorant. There are three official preparations: the *Infusum Senegæ* (dose, ½ to 1 fl. oz.), *Liquor Senegæ Concentratus* (dose, ½ to 1 fl. dr.), and *Tinctura Senegæ* (dose, ½ to 1 fl. dr.). Externally, senega is a cutaneous irritant; internally, it stimulates the alimentary, nasal, and pulmonary mucous membranes.

Senile Insanity.

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See also INSANITY, NATURE AND SYMPTOMS (*Etiological Varieties*); DEMENTIA; GENERAL PARALYSIS; etc.

INTRODUCTORY.—The onset of old age is characterised by the setting in of processes of atrophy, affecting almost all the organs of the body. It is a phase of life as natural and physiological as is the growth of these organs during the period of evolution. The material used up in the body is no longer fully replaced by assimilation; denutrition advances more rapidly than nutrition, and atrophy results. Corresponding to the degree of atrophy there is weakening and loss of the functional activities. The grey hairs, the wrinkled skin, the toothless and sunken jaws, the tottering and feeble gait, the loss of memory, and the weakening of the mental vigour are all alike expressions of this process of regression and decay which leads painlessly and insensibly to the death of the individual. To quote Sir James Paget: "Life is so far from being 'the sum of the functions that resist death' that it is a constant part of the history of life that its exercise leads naturally to decay, and through decay to death." These involutionary processes do not commence at any fixed age, and do not affect the organs in any uniform course. In one individual the cardio-vascular system fails early, in another the nervous system or the mental faculties are first to give way.

As regards the nervous system, most writers agree that involution should not begin before the sixtieth year. After that period of life the brain, which has remained practically uniform in weight from the thirtieth year, slowly decreases in volume. The convolutions, especially in the frontal lobes, are generally atrophied, with a corresponding increase of cerebro-spinal fluid in the widened sulci. The pia mater is thickened and milky. Microscopically the brain shows many changes affecting not only the nerve elements but also the blood-vessels and supporting structures. The nerve cells are shrunken; a yellow granular pigment forms in the cell and often replaces the greater portion of the protoplasm. The chromophile particles are diminished in number and their shape and arrangement are altered. The processes atrophy and the gemmulæ disappear. These changes are very far from uniform even in the same brain area; some cells apparently escape them, while others may be represented merely by a small mass of pigment. The neuroglia is increased, especially in the outermost layer of the cortex, and there is as a rule subpial felting. The larger blood-vessels are frequently the seat of atheroma; the smaller ones are always affected by a greater or less degree of hyaline-fibroid change.

Even in the brains of the most healthy persons, and in those who have shown no mental symptoms, these groups of changes occur so constantly, and in so marked a degree, that the nature of the process underlying physiological senile involution is still a matter of debate. One set of authorities regards the changes in the nervous elements as the primary and all-

important factor, holding them to be merely the expression of a gradual decay and failure of energy. Others maintain that the nerve-cell degeneration is secondary to a general auto-intoxication, caused by the atrophied and altered state of internal organs leading to perverted metabolism, and the formation of toxines, which, acting as irritants, cause the mentioned changes in the neuroglia and vessels. From these changes, they hold, result the atrophy and degeneration of the nerve-cells.

There is no doubt that pathological processes run more closely parallel in senility to the physiological than at other periods of life, and age, in itself, may thus predispose to pathological change, but this cannot become actual without the influence of some other factor. A man's years are merely the index of this modification of his relationships to disease.

Normal Old Age.—Generally the first signs of the mental decadence in old age are a gradual loss of memory, a weakening of the imagination and of the affective faculties. The powers of assimilation and of reaction to new stimuli become much slower. The attention is less prompt and more difficult to concentrate on one issue. The judgment, strengthened by a long experience of life, often remains sound, and the old man is able to direct his juniors with that wisdom which has always been accredited to age. The loss of the reproductive functions has restricted the mental horizon and has lessened the intensity of a great group of associations, but it has also rendered the physiological old man free from the impulses of passion and of vice. He is neither apathetic nor subject to outbursts of anger. The imagination no longer aids so briskly in dealing with new combinations of circumstances; where the younger man reacts to his environment, the old man conforms to his past life. The natural longing is now one for rest, and the more active position is often ceded voluntarily to the younger generation, whose enthusiasm is still not disillusioned. The facility of expression in speech is diminished, and the articulation is slower and less distinct. The gait and attitudes betoken diminished vigour. Though the power and elasticity of the psychical and physical processes may be weakened, yet they are in no way abnormal. As one writer has it, the normal old man is comparable to a millionaire, who, having lost one hundred thousand pounds, is still abundantly solvent.

Especially in the ranks of the very highly educated and cultured, there have been in all times examples of grand old men who have conserved their mental powers almost at the high level of their prime of life—men famous in literature, in science, and in politics who live past the allotted span and still do valuable and original work. In them it seems as if involution has been arrested at a very early period and has remained stationary. It is probable that an active and wide exercise of the mental tissues may increase their force of resistance to degeneration. One practical point is that the cultivation in earlier years of any hobby or pastime, which can be continued after the person has retired from the more serious business of life, is of great value in conserving a physiological senility. It provides the means for mental exercise and recreation at a period of life when new associations are with difficulty formed.

There is an infinite series of gradations between the old man who has retained his mental faculties almost unimpaired and those who are passing to the confines of dementia. A varying degree of mental dotage may represent the termination of the greater part of humanity, but it must not be looked upon as necessary and unavoidable.

Pathogenesis.—In the causation of departure from the normal type we find that the chief factors are hereditary predisposition, vascular disease, and toxic processes. Statistics show that while there is a much larger actual number of persons insane between sixty and seventy years of age than in the later decades, yet, taken in proportion to the living population in the same periods, the difference in ratio is by no means great. The incidence in the sexes gives a slightly greater proportion of females. Social state and occupation act only as they do in other forms of insanity.

As regards hereditary predisposition, we may assume that even where this is present, the inherited brain weakness cannot be so marked or so potent as in those who are afflicted in earlier years with mental disorder. There must have been a considerable degree of stability, otherwise the brain tissue would have been unable to resist the changes during adolescence and the climacteric and the stress of active life. As Dr. Clouston puts it: "To have survived, therefore, the changes and chances, the crises and perils of life, with intact mental function until after sixty, means slight neurotic heredity or great absence of exciting causes of disease." The statistics given by the various writers differ considerably. Dr. Clouston gives 13 per cent, Dr. B. Lewis states his figures at 22 per cent, while Verga gives a still higher proportion, but in all cases the percentage is lower than the average for all cases of insanity. A tendency to early involution appears in certain families unassociated with any exciting cause, and evidently due to an inherent brain weakness. Closely related to hereditary proclivities are those peculiarities which constitute the insane temperaments. In these cases suspicion, egotism, diffidence, or avarice is present throughout life, but may be kept in restraint while the person has the power of normal reaction to his environment. As this, however, weakens in old age or by an unrela-

tional decadence accentuating these malformities, the person may at the senile period pass the borderland and become insane.

Previous attacks may render the patient liable to break down again at the senile epoch. These cases, while they do not come under the strict category of senile insanity, yet have at this period most of the symptoms of their aberration altered and coloured by the underlying process of regression.

Vascular lesions act powerfully both as predisposing and exciting causes of abnormal senility. The most common diseases are endarteritis deformans, atheroma, and fatty degeneration affecting the larger vessels, and hyaline-fibroid changes in the smaller vessels of the cortex and also in the walls of the lymph channels. These changes, leading to a gradual diminution of the lamina of the vessels, and to a thickening of their walls whereby osmosis is diminished, cause a gradual malnutrition and degeneration of the brain areas supplied by them. Thrombosis and embolic conditions are prone to occur, and softening of small areas of brain matter may ensue. Hæmorrhage may also result from the rupture of miliary aneurysms or from the walls of new vessels which frequently accompany these changes. Dr. Ford Robertson has found these softened or hæmorrhagic areas in 40 per cent of post-mortem examinations in cases of senile insanity. The gross lesion may have been present only a few days in many of these cases, and may have been the immediate cause of death, but the vascular changes which preceded them had always existed for some time. These softened areas are in the great majority of cases multiple, often affecting symmetrical areas in the two hemispheres. They may be minute or microscopic, but often involve large areas, and wherever found they point to widespread degeneration of the brain substance, such as could not exist without abnormal mentalisation.

While not accepting the toxic theory as a cause of physiological regression, we must admit that it is one of the greatest factors in the production of pathological change. Indeed, in cases of typical senile insanity the autotoxic basis is undoubted. As pointed out by Dr. Robertson, the process finds expression not only in the brain but in all the organs of the body. The liver is fatty and atrophied, the kidneys cirrhotic, the lungs are emphysematous or show chronic congestion, the intestines are frequently the seat of catarrhal changes. The toxines may either be formed in the body or introduced from without. They act both as direct poisons to the nerve cells and processes, and also by their effects on the vascular system and neuroglia. Alcohol and syphilis are probably the two principal examples. In many cases it will be found that alcohol has been indulged in for years, without apparent result, yet when decadence sets in a pathological dementia or some psychosis becomes evident. This may even follow, in cases who have been temperate in their use of alcohol for years, as a result of excessive drinking previously. The nerve cells are able probably to resist the effects of the toxines during the period of nerve-cell growth and maintenance, but so soon as their own involutionary regression sets in, then the slightest interference with their nutrition acts powerfully, and determines that their involution shall be pathological. Dr. Lewis has traced this cause in no less than 40 per cent of cases. Syphilis also acts similarly, and though quiescent for years, frequently exacts this penalty in old age. Influenza has been increasingly evident in recent years as a cause of abnormal senility. This is especially the case when there have been recurrences of the illness. When there is a combination of these toxic-producing factors, as in cases of syphilis with alcoholism, or where influenza follows one of them, the tendency to degeneration becomes very marked. Rheumatism, gout, and chronic Bright's disease are by no means uncommon members in this group, and lead poisoning is also not infrequently noted. Over and above these are the cases where the toxine results from perverted metabolism in the intestinal canal or elsewhere. It is probable that the intoxication is in many cases due rather to a failure in the formation of the protective alexins, than to an excessive production of morbid toxines.

Over-exertion of the brain, mental stress and worry, malnutrition and traumatism are also frequent exciting causes. To have a physiological old age it is necessary for a man or woman to have lived throughout a physiological life.

Neuroses of Senility.—Apart from the psychoses and dementia, there are certain symptoms of nervous disorder observable during the senile period. These may be grouped into two classes: those associated with changes in the vessels and blood-supply, and those in which the supporting structures are involved. The first class contains cases with symptoms of giddiness, vertigo, sickness, feelings of weight in the head, and also subjective noises and visual phenomena. These are due in all likelihood to alterations in the supply of blood to the different brain areas, and when they are unilateral, as sometimes happens, they come closely into line with megrimous attacks. Dyspnœa and asthmatic conditions, especially in the early part of the night, are also notable. These are not infrequently among the first symptoms of involution, and they may pass off after the process is fully established. They are, as a rule, paroxysmal. The second group have a more organised basis, and therefore a more permanent character. Pareses, especially of muscles supplied by the cranial nerves, passing off and

recurring, paræsthesiæ, anæsthesiæ, ataxic signs in the lower limbs, and transitory paresis or loss of power over the sphincters, all belong to this class. Epileptoid seizures, and even true epilepsy, may develop, and are always of grave import. There is a third group probably due to toxic absorption: slight fever accompanied by loss of appetite and even refusal of food, confusion of ideas passing gradually into a mild degree of stupor or hebetude. The condition lasts only for twenty-four to forty-eight hours. It is probably a milder degree of the toxic condition which forms the third group in the delirium of collapse.

Dementia.—Dementia, or senile dotage, is the termination of life in most individuals. So common is it that its lesser degrees are accounted almost normal by the large proportion of people, and those who have retained their mental power unabated are considered fortunate and to be congratulated. Verga even speaks of the "fatal psychical heritage of longevity." In the majority of cases the person affected is able to pass through the few remaining years of life without exciting attention or comment, and it is only when the degree becomes marked that the pathological basis of the condition is suspected by most. The dementia is due to the involutionary processes setting in either precociously, or with irregularity, or with so great depth and rapidity that the individual ceases to keep pace with his fellow-men.

(*a*) *Simple Dementia.*—The onset may be exceedingly gradual and no exciting cause may be noticed, or it may be determined by a slight illness or change in the habit and mode of life. The memory is affected early. The more recent events are in particular soon forgotten, while more ancient facts are often vividly recalled. Names of friends, of places, or of articles in daily use are with difficulty remembered when required, though they may be used freely and correctly when no special thought is directed to them. This loss of memory for names varies greatly from day to day. Each new fact may be correctly perceived and appreciated at the time, but forgotten at once. The memory trace of any recent event seems to be readily erased from the mind tissue, whereas older ideas run in deeper and more passable nerve channels. Those facts with many groups of associations present a greater force of resistance to the decay. Disassociation follows the usual law of degeneration, and passes progressively from the unstable to the stable, from the less organised to the more organised, and from the less to the more automatic. Old histories and tales of past-time events are repeated again and again without the person being aware of the repetition. The man or woman comes thus to think and to live in a past age. The value of any recent advance in science or art may be recognised by them when first learned; but soon forgotten, it ceases to mould their actions and thought in the future. Intellectual and scientific knowledge and business instincts little by little disappear. Ideas of time and space are lost as the dementia deepens; morning is mistaken for afternoon, or spring for autumn, and they arrange their plans and their movements accordingly, following a routine which lifelong practice has rendered automatic. They may wander from home and lose themselves in surroundings which were formerly well known to them. In the earlier stages the judgment may be fairly sound, but the energy is lacking to carry out the chosen plan. Attention has become a reflex. The affective instincts and feelings become weaker. They cease to take any interest in events, and family happenings such as formerly influenced their conduct pass more and more unnoticed. They may, on the other hand, become emotional, grave or gay on the slightest or no provocation. They may continue to be able to dress themselves, to feed themselves, and to go in and out in their old daily manner, without perceiving the changing times and fashions around them. In this second childishness they may reveal long preserved secrets to a stranger, while there is a tendency to reticence regarding their own symptoms, so that grave bodily ailments may be long concealed from their friends. Speech, in the early stages slow, hesitating, and paretic, becomes more disconnected and unintelligible, until it passes into an incoherent jargon with perhaps automatic repetition of some meaningless phrase. Sleep at night becomes more broken and unquiet, and the night may be spent in wandering about the room. This is due frequently to the rise of hallucinations of sight and hearing, or to feelings of anxiety or vague oppression, which may be associated with cardiac weakness. During the day, on the contrary, they may sleep for long periods, with drowsy and apathetic intervals. The appetite in the early stages is often good, and the food well digested. The acts of defæcation and micturition may be easily performed. When these reflexes cease to act normally, and when the old routine habits are no longer performed, dissolution is rapidly approaching.

Concurrently with these mental changes there has been progressive loss of the physical powers, so that it is only in rare exceptions that a comparatively healthy body exists with marked dementia. Some people as they grow old become small and withered, lean and dried up, with sharpened features and shrill voices; others show a tendency to the deposition of fat, an increase of bulk with imperfect texture, and they become stout and flabby, slow in movement, and gruff in voice. The bones become more fragile from atrophy and increased deposit of calcareous salts, and the body assumes the incurved attitude with bowed shoulders. The

heart, which is often hypertrophied, beats more rapidly than in adult life, and with irregularity in its action. The digestive system is subject to disorder, and diarrhœa is frequent. Passing attacks of pareses, accompanied by inco-ordination and increase of the mental confusion, and with rises of temperature, may confine them to bed for some days. They become gradually more inactive, less able to be out of bed, and increasing weakness leads by slow steps to death. This may occur from a slow marasmus, due to failure of trophic power; but generally some intercurrent disease, an apoplexy or thrombosis in the brain, or congestion of the lungs or pneumonia, cuts them off. Such is the course of simple dementia. Its duration varies greatly. It may be taken as a rule that it lasts from two to four years. There are acute cases in which all the stages are passed through in from four to six months; on the other hand, there may be periods of remission in the progress of the disease, which may defer its termination for some eight or ten years. A steady downward course is, however, the more usual history.

(*b*) *Complicated Dementia.*—The course and character of simple dementia may be altered or complicated by special features. Some of these may be briefly considered.

1. *Senile Paralytic Dementia.* — Clinically, these cases are closely allied to general paralysis, and histologically sections from the brain cortex of the two states cannot always be differentiated; facts which point to a common origin, if not, indeed, to the identity of the two conditions. These cases occur most frequently in males. The dementia is marked and rapid, characterised by facileness and fatuity. There may be delusions of grandeur more or less marked. In this class of case the motor weakness is decided, and inco-ordinations, pareses of groups of muscles, inequality of the pupils, paræsthesiæ, and other sensory phenomena, and early loss of power in the sphincter, are present. Epileptiform attacks or congestion seizures occur, as in general paralysis, and are often fatal. The course is rapid and ends fatally, usually within eighteen months.

2. *Dementia with Gross Lesion.*—The symptoms vary greatly with the situation and size of the lesion. When the damage is not too great, mild enfeeblement of all the mental functions may alone be observable, and this may not show the usual progressive nature. Usually there is irritability, emotionalism, change of character, and there may be restlessness and confusion, with degraded habits. When motor tracts are involved, aphasia or paralysis of special muscles may complicate the mental condition, and when hemiplegia or other marked result confines them to bed, trophic lesions are prone to follow. Damage to the sensory areas is often accompanied by acute hallucinations—as, for example, when blindness results from injury to the occipital lobes, the visions may be so vivid that the person imagines he has regained his sight. Many of the cases with gross lesions are very acute in their degree, and all require careful attention.

3. *Dementia with Apsychosis.*—Dementia and the psychoses act and react on one another, altering the symptomatology of both. The gradual failure of the various centres forms a very favourable soil for the growth of many false ideas, and for the rise of errors of judgment or impulsive acts, which the coexistently weakened will power is unable to check. These psychoses should be considered as a superadded factor in the clinical picture of simple dementia. They are very changing in their phases, and may pass off, leaving always the substratum of the quieter dementia. They will be considered in the following section.

Psychoses of Senility—(*a*) *Melancholia.*—This is the most common form of psychosis in senility, and it varies from the most mild to the most acute forms. There may be merely a passing want of interest in their surroundings, with feelings of inactivity and slight gloom. When more decided there are two types of cases—first, those who are very depressed and miserable, with melancholic expression and attitude, who sit mute and not moving voluntarily for hours. They are generally sleepless and constipated, with feeble and irregular action of the heart, and with coldness and lividity of the extremities. In these cases there are often feelings of great dread of impending calamity or misfortune, associated with hallucinations of sight and hearing. In the second type the mental reduction is greater, and they are the restless, excited, and agitated class who emit groanings and cries of despair. There are marked motor signs, wringing of the hands, and uneasy pacings up and down, passing into a state of intense and inco-ordinate meaningless struggles, in which there is complete oblivion to their evironment, and where there are hallucinations of overpowering vividness. Speech may be incoherent, rambling, and confused. These persons have frequently delusions that they have committed great sins, and pray incessantly to be delivered from the punishment they imagine due for these. Attempts at suicide are thus not uncommon, and may be repeated and desperate. This state is often associated with marked arterio-sclerosis. When dementia is present the depression may, in the milder cases, only be recognisable by the expression and tone of voice, and even when very marked there is a tendency to automatism in their groanings and movements which shows the underlying enfeeblement. These motor signs may be present even in the last stage of dementia, but as a rule their condition becomes then more listless and apathetic. There may be tearless weeping, which comes and goes

without observable cause. Hypochondriacal symptoms are very common. They believe that their organs are no longer acting properly, and that their food is not digested. This may pass into a true delirium of negations, in which they deny everything: "They have no body, no soul; they do not exist." Even where dementia is present, attempts at self-destruction or self-mutilation must be guarded against.

(*b*) *Mania.*—Mental exaltation may occur at any period of senility. The simplest form is that characterised by an increase of the feeling of well-being. These persons are vain, dress to appear younger than they are, and they assume the manners and engage in pursuits which have for years been laid aside. An erotic taint in the conversation and conduct is often observable. They may become so extravagant in their acts, and so overbearing in manner, as to necessitate their removal to an asylum. Their disposition may change completely, and the hard-earned savings of a lifetime may be spent in a few weeks. In the more advanced forms there is, after a short period of depression, great excitement. They are sleepless, the talk is rapid and incoherent, and the conversation may be obscene. They shout, sing, and are very noisy both by night and day. They tear their clothing, and their habits are often faulty and degraded. Onanism is an occasional feature even in men long past this climacteric. In the early stages the memory may be absolutely increased for short periods. Religious ideas may tincture the general picture, as also delusions of grandeur. The excitement and motor energy may be out of all proportion to their physical strength, and may cause sudden exhaustion and death. In comparison with the mania of other epochs of life, there is less of the angry and vindictive type, so that attacks on others are not so frequent as a rule. When associated with dementia, the increased activity and obtrusiveness of the patient reveals the full extent of the enfeeblement. The conduct is more childish, more foolish, and more changeable. The mania may pass into a subacute or chronic state, with noisy restlessness and destructiveness, and it is then very difficult to treat, the night exacerbations being marked. The patients are often wanting in cleanliness, and may pay no heed to the calls of nature. Degraded habits are the rule. There is a well-recognised type, in which there are recurrent periods of this excitement lasting a few days or weeks. The periodicity is often marked, and each attack may be followed by an interval of reaction and collapse before the normal course of the dementia is again resumed.

(*c*) *Ideas of Persecution and Paranoia.*—As in other periods of life, the rise and establishment of these ideas is slow and gradual. Delusions of persecution and of suspicion are the most common. The increasing difficulty of keeping abreast of younger and more active people is put down to unfair treatment, and the inability of their friends to assist them to animosity. There may be associated with these ideas of grandeur, that their power and talents are better than ever before. These feelings are often fostered by the persons living alone, and brooding over their imagined grievances. In many of these cases there has always been an unsociability of temperament predisposing to this condition. Delusions that their food is being poisoned, or that they are being acted on by some unseen agency, are also frequent. Illusions are also not uncommon, and errors of identity. Hallucinations of sight and hearing, and perversion of special or common sensation are often the basis of these ideas. Delusions regarding the bodily health, and often of the state of one organ, exist in some cases, and these persons may nurse this imaginary ailment for years without betraying any other mental abnormality. These cases do not show any marked tendency to dementia in many persons, and may exist for years. In dementia the ideas are less systematised and more irrational. Failure of memory often causes them to think that their property has been stolen, whereas they merely cannot remember where they have put it. In the more advanced stages the delusions are many and fleeting, and affect most of the systems. Each new fact as presented to them may be misconstrued, and may influence their thought and conduct for the short period in which it is remembered, or until a fresh idea drives it from the field of attention.

(*d*) *Insane Acts and Moral Insanity.*—Occasionally an old man who has been ideal in his conduct throughout life startles his relatives and associates by some act pointing to the loss of moral sense. He may commit adultery, or he may steal, or do some other crime. In these cases there is generally more or less unconsciousness of the gravity of the deed. They are often due to weakness or errors of judgment, or they may be impulsive acts. When the deed is not in itself criminal, as in the case of an old man marrying an unsuitable person, there may be difficulty in recognising and treating it as due to mental aberration. When dementia is also present, the abnormality of conduct is more apparent. Violent assaults may be committed, not infrequently on old acquaintances, out of all proportion to the offence against them, or from groundless ideas of persecution or jealousy. Homicide may result from a slight quarrel, or suicidal attempts made from some slight chagrin. There is in many cases a sensual nature in these acts. The climacteric may be accompanied by a degree of hyperactivity, or the enlargement of the prostate or other local irritation may cause

them. There is eroticism, sexual excess, or sexual perversion. Indecent assaults may be made or indecent exposure of the person may occur from this cause. Where the dementia is marked, the latter may also be due to mere inability to appreciate the incongruousness of their surroundings. It may be accepted that the better the mental condition of the patient, there is the greater likelihood of a repetition of similar acts, and less chance of their recurrence if the person is enfeebled, so that dementia is not altogether an unmixed evil in these cases.

Delirium of Collapse in Senile Cases.—In senility the delirium of collapse shows several special features, which are of importance from the fact that on their early recognition depends very frequently the issue of the case. They may be grouped into three classes.

(*a*) *Following Traumatism or Surgical Shock.*—The traumatism may vary greatly in severity. The delirium has been noticed after the passing of a catheter or after eye operations, but usually the shock is more marked, as after fractures, especially of the neck of femur. The patient looks comparatively well for three or four days, and then hallucinations of sight and hearing set in, often accompanied by some irregularity of the heart's action. There are delusions of suspicion, motor restlessness, babbling, incoherent talk, especially at nights, and involuntary groanings and cries. The condition may pass off in a few days, or it may lead to the setting in of dementia or permanent paranoia. Many old people who die as the result of an injury have this delirium, and the cerebral excitement undoubtedly hastens the fatal issue.

(*b*) *Following Acute Illness.*—In this group the most common forerunner is an acute illness, such as pneumonia or influenza, but it may also occur in the exacerbations of chronic Bright's disease or failing heart compensation. The mental symptoms supervene a few days to a few weeks after the exciting illness. There may be merely sleeplessness, exhaustion, and restlessness, accompanied by suspicion and hallucinations, or the delirium may pass into an acute mania or agitated melancholia with great excitement. The prognosis is always grave in the acute cases, and the result depends largely on the power of reaction of the heart to stimulants. If the heart's action improves, the outlook as regards life is favourable, but permanent enfeeblement very often follows.

(*c*) *Acute Toxic Cases.*—This group is the most important. The onset is sudden, the course is sharp and acute, and its termination is generally fatal. The patients have frequently been in failing health for some time, but without any definite symptoms. They become suddenly sleepless, excited, and agitated; food is absolutely refused. They have very acute hallucinations. There is a continual incoherent chattering, which rapidly becomes unintelligible. There is marked confusion, and they are completely oblivious to their surroundings. All motor acts are very inco-ordinate, and the limbs are often in continuous movement—picking at the bedclothes, clutching at objects in front of them, aimless tossings. They gradually pass into coma. The physical signs are usually a subnormal temperature. The pulse is very rapid, weak, and may be almost imperceptible at the wrist. The heart-sounds are feeble and reduplicated. There may be suppression of urine. The tongue is very furred and foul, and the teeth coated with sordes. The whole alimentary tract seems to be paresed. The abdomen is retracted, but the colon may cause bulging in the flanks from distension. There is incontinence of urine and fæces from paralysis of the sphincters. Death usually occurs within a fortnight of the onset of the illness. These cases are so acute that they are frequently at once sent to an asylum, where their early death is frequently a source of misgiving and regret to their relatives. They are, in many cases, examples of an "ante-mortem" delirium.

Diagnosis.—The diagnosis of the more common conditions is, as a rule, not difficult. A thorough examination of all the organs of the body should be made, and as complete a history, both recent and remote, as possible should be obtained. All the muscles of the body should be tested, and especially those supplied by the cranial nerves, for paralysis or other signs of focal lesions. If such be present, or if disease of the vascular system can be diagnosed, the mental condition is prone to be a progressive one. This is also the case where alcohol and syphilis have been the exciting agents. In examining the mental state, not only the abnormal features should be noted, but also the degree of mentalisation that still remains normal. From this, more than from the aberration, the diagnosis between a simple psychosis and one with dementia is to be made.

The history of illness or accident, with the course of the mental symptoms, is generally sufficient in the first two groups of cases of the delirium of collapse. In the toxic cases, the absence of any definite disease, the sudden onset, and the great prostration, along with the paresis of the intestinal tract, are the chief diagnostic points.

Prognosis.—Dementia, when it has once become established, is irrecoverable, and its course is a gradual downward one, terminating in death in from one to four years. The fatal issue is usually the result of some intercurrent affection, such as pneumonia or influenza, or exhaustion from diarrhœa, but a certain proportion of cases die from marasmus from gradual trophic failure due to degeneration in vital brain centres. In the psychoses the illness

may, in a proportion of uncomplicated cases, terminate in recovery, the person returning to a normal senility. This is especially the case in the milder forms of mania and melancholia. This recovery may be effected even in very old persons, and generally takes place within four to six months of the onset of symptoms. The usual course is, however, for the more acute symptoms to pass off and to leave a more or less marked degree of enfeeblement. This may, however, be so slight that the patient may be said to have recovered in many cases, though it may incapacitate him from any active vocation. About one-fourth of cases terminate in this modified recovery, and are enabled to pass the remainder of their lives quietly at home. The longer the duration of the psychosis the greater the tendency to marked dementia and death. Death results in about one-fourth of cases within a year from exhaustion or intercurrent affection. Apoplectiform symptoms are of very serious import, and few patients survive the second or third seizure.

Treatment.—(*a*) *General.*—The first point to be considered is whether the case can be kept at home or whether removal to an asylum is necessary. There can be no doubt that most cases of senile insanity, including the large majority of cases of dementia, can be satisfactorily treated at home. The habits of life of the patient have become stereotyped to his surroundings, and removal from them in many cases hastens the dementia. It is only where the excitement and noise are great, or where some special symptom, such as violence to those attending him, or sexual perversion, exists, or where delusions of suspicion against his relatives are present that it becomes necessary to separate him from his old surroundings. The means at the disposal of his friends must, however, be considered, and there is no doubt that modern asylum infirmaries provide excellent nursing and means of care and treatment. In the early stages, when the patient has considerable will power, and where he is unamenable to management by friends, it may be necessary to advise removal until the weakening of these factors renders a return to home possible. In the toxic cases of the delirium of collapse, the short course of the illness, even though the symptoms are very acute, renders it advisable to try home treatment, or to explain to his relatives that the delirium is frequently the precursor of death, which may occur within a very few days or weeks. In this class of case the nearest asylum is the best, as any prolonged journey undoubtedly hastens the end. It is probable that as the pathogenesis of these cases comes to be more fully determined, that direct treatment by means of the equivalent antitoxines may be adopted.

In home treatment, the first essential is a good nurse or nurses. Females, with their greater kindliness and tact, are preferable, and even in cases where heavy lifting, or some special point such as catheterisation, renders a male attendant necessary, it is often valuable to have supervision by a trained female nurse. In many cases relatives will answer well during the day, and if the nocturnal exacerbations are marked, the trained attendant may then be employed. In restless cases who wander uneasily about the room, constant guidance is necessary to prevent a fall and possible fracture. The rooms should be well aired and ventilated, and all excess of furniture should be removed. The clothing should be warm, and at night specially made flannel or woollen garments fitting moderately closely are necessary. These may be made fastening down the back, so that the patient cannot easily divest himself of them.

The food should be light and easily digested, and special attention should be directed to find at what hours it is best given in each particular case. Little and often is frequently advisable. The last diet at night should be non-stimulating, and one of the cereal foods serves the purpose well. In all cases there should be frequent and repeated examination of the stools for evidence of any fermentation, and especially when the diet is a farinaceous one. When fœtor in the motions is present, salol or salicylate of quinine is frequently beneficial. Night alimentation in wakeful cases often causes quiet rest to be obtained. Where food is refused, it is best to begin forced feeding early. Peptonised milk or gruel may be given at intervals by the œsophageal tube, or nutrient enemata may be tried. Alcohol may be used in moderate amount if it does not cause excitement or flushing of the face; given warm at night, it often acts as an excellent hypnotic. Where there is constipation, saline purgatives may be given in small doses daily; but all aperients should be given with caution, and especially in females enemata will often be found preferable. In cases with pareses of the lower bowel and sphincters, lavage of the rectum with large quantities of warm water, injected about 15 ounces at a time and allowed to flow out by a return tube, often gives great relief from the troublesome and repeated motions from incontinence, and may be followed by some hours' quiet sleep. Sleep should be permitted in all senile cases at whatever hour of the day.

Tonics such as the compound syrup of the hypophosphites may be employed to keep up the general nutrition, and cod-liver oil is also valuable. In cases of forced feeding as much as one ounce three times daily may be well borne and absorbed. Strophanthus and digitalis in suitable cases, by improving the state of the circulation, will often be found to benefit the mental symptoms greatly.

(*b*) *Particular.*—The neuroses with vascular

symptoms are often benefited by the use of nitro-glycerine or caffein, and phenazonum in 15-grain doses may greatly relieve the paroxysms. In the neuroses with signs of organic change, faradism to the affected muscles and limbs and iodides are indicated. Simple dementia requires treatment on general principles only. Where complicated with a gross lesion, the iodides, either alone or along with bromides where necessary, are again the most serviceable drugs. In the cases of the delirium of collapse from shock or traumatism, strychnine should be begun early, and its administration should be pressed. In cases following acute illness, digitalis and strophanthus are very valuable, and may be given along with diffusible stimulants. On the improvement of the circulatory system often depends the issue of these cases. In the toxic class of case there is almost no absorption from the intestinal canal, so that hypodermic injection should be employed. Stimulants such as ether and strychnine seem to relieve the symptoms most. Paraldehyde is the best hypnotic, and in doses of 1½ to 3 drachms gives sleep quickly and without bad after-effects. Where the taste is objected to, it may be given by the rectum. It is particularly useful in cases with weak heart or where there is cardiac dyspnœa. Bromides in 30-grain doses may produce sleep in the milder cases. Chloral is very unequal in its results, and it may produce bad after-effects. Opium is of great service in a limited class of cases. In mild melancholia with restless agitation by day it often has an excellent sedative and hypnotic action, and it may continue to do so for long periods before increase of the dose is necessary. In many cases, however, it deranges the digestion or causes an aggravation of the symptoms. Sulphonal is the best of the motor sedatives, and in 15-grain doses, repeated three times daily, may control all the motor excitement and may also give satisfactory sleep. It generally acts well in recurrent mania, and its use may enable many of these noisy and troublesome cases to be treated at home. Trional is not so uniform in its results, but may be given where the sulphonal fails to act. Hyoscine may be tried in some excited states, but requires to be given with great caution. Hyoscyamus in conjunction with bromides often acts well in cases with local bladder or prostatic symptoms. All patients require careful and constant attention, and each fresh symptom should be studied and provided for.

Senility.—*See* SENILE INSANITY. *See also* AUDITORY NERVE AND LABYRINTH (*Senile Nerve-Deafness*); EAR, MIDDLE, CHRONIC NON-SUPPURATIVE DISEASE (*Deafness from Deficient Blood Supply, Diagnosis*); FRAGILITAS OSSIUM (*Causes*); GANGRENE (*Varieties, Senile*); INSANITY, NATURE AND SYMPTOMS (*Etiological Varieties*); LUNGS, EMPHYSEMA OF (*Atrophic Form*); STERILITY (*Etiology*).

Senna *See also* PHARMACOLOGY; PRESCRIBING; LIQUORICE; etc.—There are two forms of senna in the Pharmacopœia, Alexandrian (*S. Alexandrina*) and East Indian (*S. Indica*). The former consists of the dried leaflets of *Cassia acutifolia*, and the latter of those of *Cassia angustifolia*, and both belong to the Natural Order of the Leguminosæ. Both varieties contain a glucoside, cathartic acid ($C_{180}H_{192}N_{82}SO_2$), chrysophanic acid, cathartomannite (a sugar), and sennacrol and sennapicrin (glucosides). There are seven official preparations of East Indian or Tinnevelly senna: there is (1) the *Confectio Sennæ* (containing also figs, tamarind, cassia pulp, prunes, liquorice, coriander fruit, and sugar), of which the dose is 60 to 120 grains; (2) *Infusum Sennæ* (dose, ½ to 1 fl. oz., or 2 fl. oz. as a single draught); (3) *Liquor Sennæ Concentratus* (dose, ½ to 1 fl. dr.); (4) *Mistura Sennæ Composita*, or Black Draught (containing also magnesium sulphate, extract of liquorice, etc.), of which the dose is 1 to 2 fl. oz.; (5) *Pulvis Glycyrrhizæ Compositus* (dose, 60 to 120 grains); (6) *Syrupus Sennæ* (dose, ½ to 2 fl. dr.); and (7) *Tinctura Sennæ Composita* (containing also raisins, caraway, and coriander), of which the dose is ½ to 1 fl. dr., or 2 to 4 fl. dr. for a single administration. Senna is a commonly employed and safe purgative, especially useful in the constipation of children, but frequently taken also by adults, more especially, perhaps, in the form of Tamar Indien lozenges. Senna may be given in association with a mercurial purgative, the latter being administered at night and the senna on the following morning.

Sensation. *See also* PHYSIOLOGY, NEURO-MUSCULAR MECHANISM (*Common Sensibility, Sense of Taste, Smell, Colour, Sensation*, etc.).—Conduction of sensory impulses. Dr. Henry Head's researches on sensation have shown that the mechanism of the transmission of afferent impulses is more complex than has hitherto been supposed. His deductions concerning it follow on a long series of observations on the effects of disease of the central and peripheral nervous system, on referred pain in visceral disease, on the results of nerve injuries, and on the phenomena produced in his own person by division and subsequent suture of a peripheral nerve.

Sensory Peripheral Mechanism. — Dr. Head recognises three sets of sensory impulses:—(1) *Deep sensibility*—sensations of muscular and articular movement, and sensations of deep pressure, the latter culminating in pain when the pressure is severe. (2) *Protopathic sensibility* — the sensation of painful cutaneous stimuli, and of extremes of temperature below 20° C. and above 50° C. Protopathic impulses

have also the quite definite, although negative, characteristic, of vague localisation—however clearly felt, they cannot be precisely treated. (3) *Epicritic sensibility*—tactile sense in its restricted meaning, *i.e.* the power of appreciating gentle touches, of localising stimuli, of discriminating adjacent compass points, and of distinguishing between minor variations in warmth and coolness between 20° and 50° C. These three sets of impulses travel by different paths.

The impulses concerned in *deep sensibility* are conveyed in the muscular nerves; when all the cutaneous nerves of a region are divided, the pressure of blunt objects can be recognised, but not distinguished from the prick of a sharp point; forcible pressure causes a sensation of bruising, and the position of the limb can be appreciated. *Protopathic sensibility* is conveyed in many or all of the afferent nerves, both somatic and visceral; the viscera are probably endowed with the form of sensibility which forms a part of the great reflex system of the body. All the protopathic fibres from any area converge to the corresponding posterior root, which is therefore a unit of protopathic supply. *Epicritic sensibility*, the most highly developed form, is restricted to the skin, and endows it with a special tactile sense. All the epicritic fibres of any area converge to the corresponding branch of a peripheral cutaneous nerve, which is therefore the unit of epicritic supply.

The relations of these forms of sensibility is best shown by considering the phenomena which follow division of a peripheral nerve. There is a large area of diminished sensibility, and within the confines of this a smaller region in which sensibility is completely absent. The partial anæsthesia is due to the abolition of epicritic, and the retention of protopathic sensibility; the complete anæsthesia is due to the abolition of both. The area of abolished epicritic sensibility has a well-defined margin, and coincides with the distribution of the cutaneous nerve injured; there is no overlap of fibres from adjoining nerves, hence the phrase —a peripheral nerve is the unit of epicritic supply. The zone of protopathic anæsthesia has an ill-defined outline, and does not correspond with the anatomical distribution of any nerve; the difference in the distribution of the two forms of loss of sensibility from the same lesion shows that there is much overlapping of neighbouring protopathic fibres. If, however, a nerve root, instead of a peripheral trunk, is divided, the areas of epicritic and protopathic anæsthesia coincide with one another, and with the distribution of the root in question, which is therefore the unit of protopathic supply.

Over the area of partial anæsthesia (which, as stated, has lost its epicritic, but retained its protopathic sensibility) we find (*a*) negatively that (1) light touches are not felt, (2) adjacent points are not discriminated, (3) temperatures between 20° and 50° C. are not distinguished as cool or warm; (*b*) positively we find (1) that a prick causes pain, but indefinitely localised, widely diffused, and of a peculiar burning tingling character, (2) all temperatures below 20° and above 50° C. are described simply as cold or hot. Over the area of complete anæsthesia neither thermal, painful, nor tactile impulses are felt; deep sensility, however, remains. After suture of a divided peripheral nerve the protopathic fibres are the first to regain conductivity, *i.e.* the analgesic area disappears. The epicritic fibres are very much longer—months, or even years—in recovering their function. The hyperalgesia which so often succeeds nerve injuries follows the course of the protopathic fibres; on account of the overlap it greatly exceeds the area of epicritic loss. Nutritional changes run parallel in extent and duration to the abolition of epicritic sensibility.

Sensory Spinal Mechanism.—In the cord the above threefold grouping of sensory impulses ceases to exist; the groups are dissociated, and the impulses redistributed. We have no longer to do with deep, protopathic, and epicritic sensibility, but with a group of sensations of pain, a group of sensations of temperature, a group of sensations of touch, and a group of sensations of passive position and movement and discrimination of adjacent points. Sensations of pain, heat, and cold pass up the side of the cord opposite to their point of entry; they are closely, but not inextricably associated. Touch and pressure sensations, and the power of naming spots touched ("spot naming"), are also crossed. The sensations of passive position and movement and discrimination of adjacent points pass, uncrossed, up the side of the cord at which they enter. The detailed proof of these statements rests on Dr. Head's observations, particularly on cases of Brown-Séquard's paralysis, and in general depends on the fact that if a cord lesion abolishes pain, it abolishes it entirely—we never have cutaneous analgesia with retention of pain on deep pressure. Similarly, when from a cord lesion sensibility to light touch is destroyed, so also is the sensibility to deep touch; and when the power of appreciating warmth and coolness goes, so does that of recognising extremes of temperature. Further, the loss of sense of position goes hand in hand with the loss of power to discriminate between adjacent points. It follows, therefore, that in cord lesions we get an entirely different grouping of sensory disturbances from that which occurs in peripheral lesions. Head has happily termed the peripheral distribution the "primary level," and the cord distributien the "secondary level"; there is reason to suppose that in the brain a further recombination constituting a

"tertiary level" occurs. It will be noted that the impulses which recombine—thermal, painful, and tactile—cross to the opposite side of the cord, the first two rapidly, the third more slowly; position and tactile discrimination are not recombined, and do not cross in the cord, but pass up in the long extrinsic fibres of the posterior columns of the same side. Some or all ultimately cross at the level of the nucleus gracilis and nucleus cuneatus, but it may be that those which subserve equilibration, and do not cross the threshold of consciousness, enter the same side of the cerebellum without ever undergoing decussation.

This conception of the sensory mechanism may be schematically indicated thus:—

AFFERENT IMPULSES IN

		Peripheral Nerves.	Spinal Cord.		
Muscular and Articular Nerves.	DEEP SENSIBILITY.	PRESSURE.	PRESSURE.	Combined Tactile.	Opposite side of Cord.
		DEEP PAIN.	*LIGHT TOUCH.*		
		POSITION.	*CUTANEOUS LOCALISATION.*		
Afferent Branches of a Posterior Root (unit of supply).	PROTOPATHIC.	**HEAT AND COLD.**	**HEAT AND COLD.**	Combined Thermal.	Opposite side of Cord.
		SUPERFICIAL PAIN.	*WARMTH AND COOLNESS.*		
Peripheral Cutaneous Nerve (unit of supply).	EPICRITIC.	*LIGHT TOUCH.*	DEEP PAIN.	Combined Painful.	
		CUTANEOUS LOCALISATION.	**SUPERFICIAL PAIN.**		
		WARMTH AND COOLNESS.			
		DISCRIMINATION OF POINTS.	POSITION.	Uncombined.	Posterior Columns of same side of Cord.
			DISCRIMINATION OF POINTS.		

Senses. *See* Amblyopia (*Toxic, Colour Sense*); Insanity, Nature and Symptoms (*Sense-Perception*); Nose, Examination of (*Senses of Smell and Taste*); Physiology, Neuro-Muscular Mechanism (*The Senses*).

Sensibility. *See* Spinal Cord, Medical (*General Symptomatology, Sensory Symptoms*). *See also* Alcoholic Insanity (*Clinical Types, Perversion of Common Sensibility*); Physiology, Neuro-Muscular Mechanism (*Senses, Common Sensibility*); Sensation; Visceral Pain.

Sensitiser.—In the nomenclature of immunity the term sensitiser was given by Bordet to Ehrlich's intermediary body.

Sensorium.—The part of the brain exclusively concerned with sensation.

Sensory.—Relating to sensation; opposed to *motor*; thus a sensory nerve is one which conveys sensations from the skin and organs of special sense to the centre (brain and cord).

Separate System. *See* Sewage and Drainage.

Separator.—An instrument for separating teeth too closely set together, or for detaching the periosteum.

Sepsis.—The poisoning of the system by infection with the products of putrefaction or of other pathogenic organisms. *See* Labour, Post-partum Hæmorrhage (*Sequelæ, Sepsis*); Labour, Operations (*Induction of Premature Labour, Dangers*); Puerperium, Pathology (*Puerperal Infection*); Pyæmia; Septicæmia.

Septan.—Returning every seven days, *e.g.* septan fever.

Septic Tank.—An impermeable air-tight tank used in the anaerobic process of disposal of sewage. *See* Sewage and Drainage (*Sewage Disposal, Methods*).

Septicæmia.

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Syn.—Septic Infection.

The terms sapræmia, septicæmia, and pyæmia are in common use for designating different forms of septic infection. In *sapræmia* the symptoms are produced by the absorption of soluble toxic substances from the site of a wound; the causal bacteria do not themselves pass into the circulation. In *septicæmia* the micro-organisms pass into the circulation, and the resulting clinical condition is due partly to the action of toxines produced at the original site of invasion, and partly to the action of the micro-organisms in the blood-stream. The micro-organisms do not pass from the blood-stream into the tissues. In *pyæmia* the micro-organisms not only circulate in the blood, but are deposited from the blood in different organs and tissues. It should at the outset be mentioned that the distinction between these different conditions is a practical one, founded largely on clinical experience, and also to some extent on experimental investigations. There is no very sharp dividing line between the different conditions, the differences being mainly those of degree. The etiology of sapræmia, septicæmia, and pyæmia is similar.

The bacteria commonly associated with this morbid state are streptococcus pyogenes, staphylococcus pyogenes aureus, albus, and citreus. These frequently exist in combination. Many records have also been published describing cases due to unusual bacteria, *e.g.* pneumococcus, and bacillus septicus putridus, and other forms. Much experimental investigation has been directed to a study of the toxic substances which give rise to septicæmia and pyæmia, but notwithstanding this it must be admitted that we are not yet in a position to state decisively why one case becomes pyæmic while another is septicæmic. The secret of this is probably to be found in variations in the *individual reaction*; no two people react precisely alike to the same toxic agent.

Clinical Features.—These are best described by reference to the symptoms observed in a case of sapræmia. A few hours after a person receives a bruise or cut, *e.g.* a post-mortem wound, constitutional symptoms set in; there is a general sense of discomfort, chilliness, with disinclination for physical or mental work. The temperature becomes slightly raised, the appetite is deranged, the tongue furred, with constipation and headache. The urine may be diminished in amount; the skin is dry, or, more rarely, may be slightly clammy. These symptoms as a rule readily disappear, provided immediate attention is paid to the wound and careful regulation of the general health for a few days. The wound should be thoroughly cleansed with a warm antiseptic lotion and thereafter suitably dressed. The bowels should be opened by a saline draught, and the function of the kidneys and skin stimulated by the free ingestion of bland diluent drinks and the use of a warm bath. For a few days the diet should be of a light and nourishing nature. Under this regime, as a rule, the symptoms speedily subside, unless the patient's general resisting power was low at the time of the injury, in which event the case may become one of typical septicæmia or pyæmia. The general constitutional symptoms of septicæmia are the same as those already mentioned, and it will suffice to refer briefly to some special features of septicæmia. The *site of invasion* is the first point of importance. While in a case of septicæmia following an open wound, as in the above, the site of invasion is clear, not uncommonly no source of infection can be determined. In these circumstances the source of infection is to be sought for in one or other of the free mucous surfaces of the body, and more especially the gastro-intestinal tract and utero-vaginal mucous membrane.

The Rapidity of Onset of Symptoms. — In sapræmia the symptoms develop more quickly and reach their acme sooner than in septicæmia. Whereas in the former the temperature would speedily rise to 103° or 104° F., in the latter the temperature and other changes are less severe in the early stages.

Duration of the Symptoms.—If the symptoms described persist notwithstanding the adoption of the appropriate measures already referred to, the case may be regarded as one of septicæmia or pyæmia.

Pyæmia has in addition certain characteristic features. The temperature chart is distinctive. It shows the swinging temperature of a general septic infection, but superadded to this there are at irregular intervals sudden exacerbations of temperature accompanied by rigors and heavy sweating. In both septicæmia and pyæmia there may be gradually advancing emaciation

with other symptoms, *e.g.* anæmia, jaundice, sweet-smelling breath, sleeplessness, delirium, and other symptoms arising from the severity of the general septic infection.

Pathology. — The pathological appearances are similar in the two conditions, but in pyæmia a special characteristic is the presence of secondary foci of suppuration or septic infarctions in different organs and tissues. The kidneys, lungs, and brain are the most frequent sites of these septic infarctions, as these organs have end-arteries; while the liver, lungs, and kidneys are the most frequent sites of secondary abscesses. Marked cloudy swelling of the liver, kidneys, and heart muscle is present both in septicæmia and pyæmia; the various serous membranes, the pleura, peritoneum, or joints may be in a state of acute inflammation; the blood itself is usually fluid and markedly dark in colour. There are also changes in the bone marrow, but the exact nature of these changes has not been so fully determined in the human subject as in lower animals. These changes are doubtless of the first importance.

Diagnosis.—The diagnosis of septicæmia is usually easy, but it is more difficult to determine the exact source of infection in every case. We must realise that the source of infection may be any one of the free surfaces of the body, and each must in turn be the subject of investigation. In women special attention should be paid to the utero-vaginal mucous membrane, and we must remember that a very small breach of surface may suffice to allow of septic intoxication. Further, a hint of the possible source of infection may be obtained from a careful inquiry into the clinical history, which may reveal the fact that the patient had suffered from a trifling leucorrhœa, indigestion, or hæmorrhoids for some time previously.

The differential diagnosis has to be made from (1) various acute infective fevers, especially *typhoid*. The all-important test here is the Widal reaction.

(2) *Tuberculosis* may simulate septicæmia, but a careful examination of the chest, and of the temperature chart and the clinical history, will usually suffice to clear up this point. Great assistance may be obtained from a histological examination of the blood. In tuberculosis leucopœnia is present, whereas in septicæmia leucocytosis is the rule. (*See* article "Leucocytosis," vol. v.) In every doubtful case of this kind no investigation is complete without a careful examination of the blood, which must include its examination by means of stained films.

(3) The blood investigation will be the means of making in addition a differential diagnosis from malaria, whose symptoms may present many features in common with septicæmia.

(4) *Acute rheumatism* and *acute and subacute rheumatoid arthritis* may in certain cases simulate a general septicæmia. The differential diagnosis is here not very important, as some distinguished authorities hold that acute rheumatism is merely an attenuated pyæmia due to the action of streptococcus pyogenes.

(5) *Septic or ulcerative endocarditis* is to be regarded as a form of pyæmia, with the most prominent site of incidence—the involvement of heart muscle.

(6) There are *certain rarer affections*, such as actinomycosis, abscess of the liver, and the like, which occasionally may present difficulties in the way of diagnosis.

Treatment.—The first essential is the surgical cleansing of any known primary focus. If the sepsis is ascertained to be due to the streptococcus the antistreptococcic serum may be employed, as cases have been recorded where benefit followed its use. In cases of mixed infection this serum has been found of little or no value. The medical treatment of the symptoms must be carried out on general medical principles. The strength of the patient must be maintained by suitable diet, *i.e.* one with ample albumin and carbohydrate supplied in an easily digestible form. Stimulants may require to be given freely. The temperature must be controlled by antipyretics, preferably by large doses of quinine, and salicylate of soda in combination with phenacetin. Hydrotherapeutic measures are also of the greatest service. Mere sponging of the limbs with tepid water and ammonia or vinegar are useful in reducing the febrile state and conducing to the patient's general comfort. Convalescence is usually protracted, and it may be many months before the patient is finally restored to good health. A degree of anæmia may persist for a long time subsequently unless the case be suitably treated with blood tonics in the earliest stages of convalescence.

Septicæmic Plague. *See* Plague (*Types*).

Septico-. — In compound words *septico-* (Gr. σήπω, I make rotten) means belonging to putridity or to septic infection; *e.g. septicogenic* (producing putrefaction), *septicophlebitis* (phlebitis due to sepsis), and *septicopyœmia* (septicæmia with pyæmia). *See* Puerperium, Pathology (*Puerperal Infection*).

Septipara.—A woman who is passing through her seventh confinement, or who has been pregnant seven times.

Septum.—A partition; *e.g.* the *septum auricularum* of the heart, the *septum lucidum* of the brain, the *septum nasi*, the *recto-vaginal septum*, etc. *See* Labour, Injuries to the Generative Organs (*Laceration of the Vagina*); Nose, Diseases of Nasal Orifices and Septum (*Affections of the Nasal Septum*).

Septuplets.—The birth of seven infants at one time as the result of a single gestation; the cases recorded in the human subject must be regarded as doubtful.

Sepulture. *See* Burial Places; Cremation.

Sequela.—A morbid state arising as a consequence of a preceding disease or malady, and following upon it; *e.g.* nephritis may be a sequela of scarlet fever. It is sometimes difficult to distinguish between sequelæ, complications, and relapses.

Sequestrum.—A piece of dead bone, lying partly or completely detached and usually in a cavity; the formation of such a piece of bone is called *sequestration*, and the removal of it is called *sequestrectomy* or *sequestrotomy*. *See* Bone, Diseases of (*Acute Suppurative Osteomyelitis and Periostitis, Pathological Anatomy*).

Seriawan. *See* Sprue (*Synonyms*).

Sericeps.—An arrangement composed of loops of ribbon which used to be attached to the fœtal head in order to expedite delivery of the child in labour; its place is now taken by the forceps. *See* Labour, Operations (*Forceps*).

Sero-.—In compound words *sero-* (Lat. *serum*) means relating to serum, or serous; *e.g.* *serocolitis* (inflammation of the serous or peritoneal covering of the colon), *serofibrinous* (made up of serum and fibrin), *seromucous* (composed of serum and mucus), *serosanguineous* (consisting of blood and serum), etc.

Serotherapy.—The treatment of disease by means of sera, *i.e.* preparations of the blood of specially prepared animals or of immunised persons.

Serpentariæ Rhizoma.—Serpentary or Virginia Snakeroot, the dried rhizome of *Aristolochia serpentaria* (or *Aristolochia reticulata*), contains a bitter principle (aristolochin), an alkaloid (aristolochine), a volatile oil, and resin; it acts, like calumba, as a bitter tonic and stomachic; and there are three official preparations—the *Infusum Serpentariæ* (dose, ½ to 1 fl. oz.), the *Liquor Serpentariæ Concentratus* (dose, ½ to 2 fl. dr.), and the *Tinctura Serpentariæ* (dose, ½ to 1 fl. dr.). *See also* Aristolochia.

Serpiginous.—Creeping (Lat. *serpere*, to creep); *e.g.* certain skin eruptions and ulcers are so called because they tend to advance in one direction and to heal or recede in the opposite.

Serrated.—Saw-like, with teeth like those of a saw, *e.g.* a serrated suture such as exists between some of the cranial bones.

Serratus.—The name given to certain toothed muscles, *e.g.* the serratus magnus, an important muscle of the back. *See* Nerves, Peripheral (*Injuries, Nerve to the Serratus Magnus*); Shoulder, Diseases and Injuries of (*Paralytic Deformities, Paralysis of the Serratus Magnus*).

Serre-fine.—A pair of fine metal forceps, used to compress divided vessels, and acting by means of a spiral spring.

Serre-nœud.—An instrument used for compressing (by ligature) the pedicle of some body (*e.g.* a tumour) preliminary to its removal.

Serum. *See* Blood (*Plasma and Serum*); Physiology, Blood and Lymph (*Coagulation*); Pigments of the Body and Excreta (*Serum*).

Serum-Reaction. *See* Immunity, Recent Views (*Pfeiffer Phenomenon*); Typhoid Fever (*Diagnosis, Widal's Reaction*).

Serum-Therapy. *See* Therapeutics, Serum Therapy; Anthrax (*Treatment*); Heart, Myocardium and Endocardium (*Malignant Endocarditis, Widal's Test*); Immunity (*Serum Therapeutics*); Kidney, Surgical Affections (*Renal Tuberculosis, Serum Therapy*); Puerperium, Pathology (*Puerperal Infection, Treatment by Antistreptococcic Serum*); Snake Bites (*Serum Therapy*); Stomatitis, Gangrenous (*Treatment by Antistreptococcic Serum*); Suppuration (*Treatment*); Tumours, Inoperable (*Treatment, Serum Therapy*); Typhoid Fever (*Pathology, Serum Diagnosis*).

Service Reservoir.—A water reservoir for the supply of a part of a town, or in case of an emergency; it only contains enough water to last for a few days, and so differs from the large storage reservoir; it is of special use in a hilly town, and there may then be several of them.

Sesame Oil.—The *Oleum Sesami* is obtained from the seeds of *Sesamum indicum*, and is used in place of olive oil in the pharmacy of Eastern countries; it is officinal in the Indian Addendum to the British Pharmacopœia; Teel oil or Benne oil.

Sesamoid.—Resembling in shape a sesame seed, *e.g.* the sesamoid bodies or bones developed in tendons such as those of the thumb.

Sesqui-.—In compound words *sesqui-* (Lat. *semis*, half, *que*, and) means one and a half; thus a *sesquisalt* is one containing one and a half times as many parts of the element as does the protosalt of that element.

Seton.—A thread passed through a fold of skin to produce a continuous local irritation

or maintain an opening for discharges. *See* Issue.

Seven-Day Disease.—Tetanus neonatorum. *See* New-born Infant, Diseases of.

Seven-Day Fever. *See* Typhoid Fever (*Synonyms*).

Seventh Nerve. *See* Facial Nerve and *Cross References.*

Sevum Præparatum.—The fat of the abdomen of the sheep, or *suet*; it contains olein, palmitin, and stearin; and it is used in pharmacy in making ointments.

Sewage and Drainage.

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In dealing with the question of house drainage, sewerage, and the disposal of sewage and house refuse, it must be understood that the conditions laid down are applicable both to town and country districts unless when special distinction is made in the case of the latter.

The following are the essential conditions applicable to all drainage systems:—

1. Immediate and thorough removal.
2. Free ventilation of drains and sewers.
3. Perfect disconnection.

In judging of the efficiency, therefore, of any sanitary appliance or drain their self-cleansing capacity is an all-important consideration, and no system can be considered satisfactory which does not, in all its details, comply with this condition. Of course, as regards the drains themselves, it is hardly possible that flushing can be carried to such an extent as to insure perfect cleanliness; and, in order to guard against nuisance, the second essential, ventilation, must be complied with, the inlets being so placed as to allow a current of air to pass along the whole course of the drains towards the outlet ventilators, which should be carried up the houses, with as few bends as possible, and terminate at points as far removed as practicable from windows and chimneys. Still, notwithstanding these precautions, there is always a risk that the resistance offered by house traps will be overcome, owing to air pressure in the drains, the result of a sudden inrush of sewage or the accidental stopping of the ventilation openings; and to guard against this the third essential becomes necessary, namely, that no house wastes shall communicate direct with a drain, but discharge on to an outside trap, the main drain itself being disconnected from the sewer or cesspool, as the case may be, by a free opening, on the house side of which is the terminal trap of the system. An exception to this rule of disconnecting house wastes has to be made, however, in the case of soil-pipes and slop sink-wastes, which, for obvious reasons, must be directly connected with the drain; but as it is, or should be, the invariable practice to carry up these wastes as ventilators, there is little risk of the house traps being forced, as the air pressure will relieve itself at the point of least resistance.

In most houses the soil-pipe ventilator answers the purpose of the drain ventilator; but if it should happen that the soil-pipe connection is not at or near the top end of the drain, or if there are any long tributary drains with which soil-pipes are not connected, it is necessary to provide special ventilating shafts. In such cases, as the ventilating pipe will spring from the dumb end of a drain, if iron is the material used, what is known as a rust trap must be placed at the bend of the ventilators, otherwise the scaling which invariably takes place will cause rust to collect at this point and ultimately entirely close up the pipe. If lead pipes are used as ventilators this precaution is unnecessary.

There are two systems of sewage and excrement removal in operation—the *water-carriage system* and the *conservancy system.* In the former case solid fæcal matter is discharged into the drains from water-closets in, or in connection with houses, while in the latter slop water only enters the drains, provision being made for excrement disposal by privies, pails, or earth closets, the last-mentioned being only practicable in the case of villages or individual houses. There can be no question that the water-carriage system is the right one, and it is now gradually replacing the objectionable conservancy system in most towns.

The term *separate system* is applied to a water-carriage system in which separate channels are provided for the rainfall; and, from a sewage disposal point of view, it is important that every town should adopt this system as far as possible, and so keep the volume of sewage to be treated within reasonable limits.

Drains.—It is not an uncommon practice to use six-inch pipes for house drains; but this is a mistake, as, even in the case of very large establishments, four-inch drains are amply sufficient, and by increasing the diameter beyond that which is necessary, the rate of flow of the sewage is lessened, and the self-

cleansing capacity is correspondingly diminished. Although the use of iron pipes with caulked lead joints is now becoming more common, the usual practice is to use glazed socketed stoneware pipes. These should be carefully selected; the sockets should be deep and perfectly round, to allow of a good joint being made, and there should be no defects in the glaze.

In laying drains the trench should be dug in sections, and have a uniform gradient in the case of four-inch pipes of not less than 1 in 40, care being taken not to remove more soil at any point than is necessary, so that the pipes may rest on a firm bed. If the drain has to be laid in loose or made-up ground, it is necessary to lay a bed of cement concrete 6 ins. by 18 ins. for the pipes to rest upon. Where bends occur manholes should be constructed, the curve being formed in the floor of the manhole by half-channel pipes.

All joints should be made of Portland cement, care being taken to prevent the cement from projecting into the pipe, and thus causing an obstruction to the flow of the sewage. The best way of guarding against this is to ram spun yarn, previously soaked in fluid cement, into the socket to a depth of about an inch, the joint being completed either with neat Portland cement, or a mixture of equal parts of cement and fine clean sand (*see* Fig. 1). In laying the pipes the soil should be removed under each socket, so as to allow the bodies of the pipes to rest firmly on the bed of the trench, and also facilitate manipulation in making the joints. Before filling in the trench the drain should be tested in sections by means of water, the lower end being sealed up by means of a drain-stopper, and a curved drain-pipe being temporarily fixed at the top end with its socket turned upward at right angles to the drain; the water is then poured slowly into the drain until it is filled up to the socket of the temporary pipe, and if the water retains its level say for four hours the section may be passed as sound. In filling in the trench, the soil must be carefully packed on either side of the pipes in order to guard against the risk of displacement and consequent fracture of any of the joints. It is well, if possible, not to carry a drain under a house; but if this cannot be avoided the section under the house should be entirely surrounded by 6 inches of cement concrete, or, better still, iron pipes with caulked lead joints should be used.

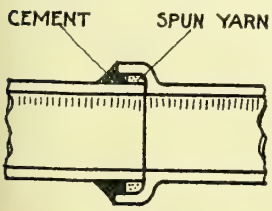
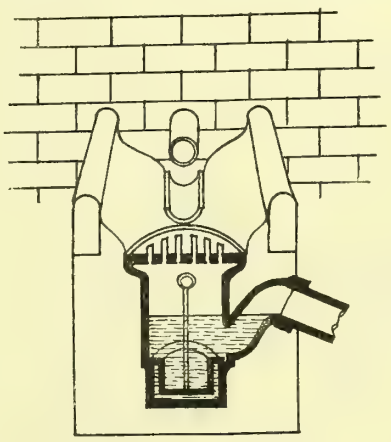


FIG. 1.

Sewers are constructed of pipes or built of bricks, according to their size, and in the former case the same rules apply as in the case of drains. Manholes should be constructed at intervals of not less than 100 yards, and the convenient points for these are where tributary sewers join. It is essential also to place a manhole at every point where a sewer has to depart from its straight course.

Traps.—Traps are essential both in connection with drains and sanitary appliances, but they have to be used with discretion, as they all have a tendency to obstruct the flow of sewage. The only point at which a trap should be fixed in the course of a drain is where it joins the sewer or cesspool, as the case may be, or as near that point as possible. Every inlet to a drain, however, except in the case of water-closets and slop closets, should be trapped; for example, down spouts and yard drainage should discharge into gully traps, and all sink, lavatory, and bath wastes should be trapped within the house and discharge on to a gully trap outside. In the case of water-closets and slop closets, as already stated, it is neither practicable nor desirable to introduce any other trap than that which is connected with the appliance itself. Cellar traps are a frequent source of danger, first, because it is difficult to secure proper disconnection, and, secondly, because they frequently become unsealed from evaporation owing to infrequent use. It is desirable, therefore, to abolish cellar drains entirely, as if they exist for the purpose of carrying away subsoil water the cellar itself should be abolished, while if the only purpose they serve is to facilitate the washing of cellar floors that is not sufficient justification for their being provided.

There are various forms of traps, but the only satisfactory ones are those which are designed on the principle of a syphon. The bell trap, the D trap, and the dip-stone or Mason's trap are all objectionable, chiefly because they are not self-cleansing, and the only forms which need


FIG. 2.

be considered are the gully trap and the syphon trap proper.

A good form of gully trap is shown in the drawing (Fig. 2); it is used for the purpose of

yard drainage or for receiving the discharge from down spouts, and the wastes from sinks, lavatories, baths, and laundries. It will be noticed that the one represented is provided with a bucket, which facilitates the removal of any deposit which may take place; but this, although a useful, is not an essential addition. Fig. 3 represents a syphon trap which is used for disconnecting the terminal drain from the sewer or cesspool. It will be noticed that on the house side of the trap an opening is provided, and this should be connected with a surface grating by means of pipes, so as to act as an inlet for air to pass along the drain and up the ventilating shaft or shafts at the top end of the system. A better arrangement, however, is to construct a manhole at this point (Fig. 4), with which all the tributary drains may be connected as shown, this being the only manhole in the system which should have an open cover to act as an inlet for ventilation. It is not always possible to obtain a self-cleansing gradient, in which case artificial flushing should be resorted to by means of an automatic flush tank holding from 80 to 100 gallons, which should be adjusted to discharge, say, twice a day. The best tank for this purpose is Field's (*see* Fig. 5), which discharges by syphonic action even with a drop supply.

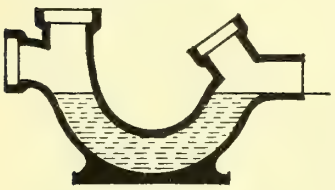


Fig. 3.

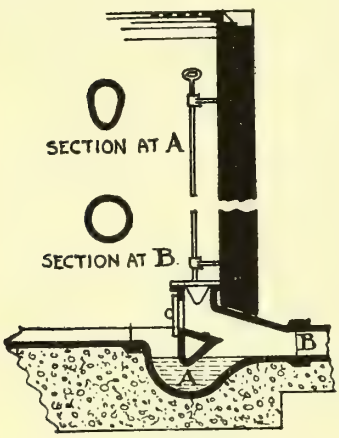


Fig. 4.

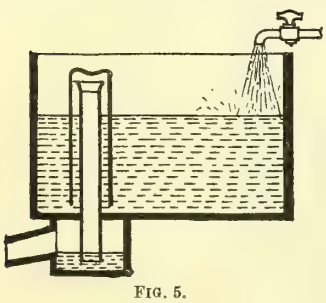


Fig. 5.

Cesspools should be avoided where possible, but in rural districts a sewer is not always available with which to connect, and in such cases they may be the only alternative. They should be constructed in brickwork set in cement, and without overflows, a chain pump being provided to allow of the sewage being pumped on to land periodically. If suitable land is available, however, and the fall allows of it, the cesspool may be constructed on the principle of the "septic" tank, to be presently described, the effluent being applied to land; or—as an alternative to land—a small biological filter may be constructed in the manner set forth later, the area necessary in the case of a household of from ten to fifteen persons being 2 superficial yards, and the depth 5 to 6 feet.

Water-Closets.—In constructing a water-closet attention should be paid to the following points: —(1) At least one wall of the closet should be an outside wall, in which there should be a window, and preferably the apartment should be separated from the house by a short passage with cross ventilation. (2) The apparatus itself should be provided with an ample water flush, which should not come direct from the service pipe, but from a special cistern connected with the service pipe by means of a ball tap. (3) The soil-pipe should be placed outside the house, being connected with the drain below without the introduction of a trap, and carried up full bore to above the eaves of the house as a ventilator. Between the closet and the soil-pipe there should be an efficient trap, and to avoid the risk of its becoming unsealed by syphonage, an anti-syphonage pipe should be carried from the waste beyond the trap to join the soil-pipe ventilator above the highest junction—a precaution which is specially indicated if more than one closet discharges into the same soil-pipe. (4) The soil-pipe, which should not be more than 4 inches in diameter, may be constructed of drawn lead with proper "wiped" joints, or if iron is used the pipe must be sufficiently strong to allow of the joints being caulked with lead, as if putty is used sooner or later the joints will become defective.

As regards the apparatus itself, several varieties are met with—good, bad, and indifferent. The valve and wash-down are good types; the pan and wash-out are bad types; while the plug closet is not good enough to be classed in the first category, nor bad enough to be included in the second. As space will not allow of a detailed description of each of these types of closet, only the valve and the wash-down will be considered in detail.

All things considered, perhaps the valve closet (Fig. 6) is to be preferred to the wash-down (Fig. 7), but if economy has to be considered the latter has the advantage. There is a good deal of mechanism connected with the valve closet, and unless the workmanship is good throughout, sooner or later the apparatus will get out of order; it is important, therefore, in purchasing such a closet to select the very best, which is usually the most expensive; the simplest wash-down closet, therefore, if the design is good, is to be preferred to a cheap valve closet.

With the aid of the drawing and the following description the chief details of a valve closet will be easily understood:—It consists of an earthenware enamelled basin in which water is retained by the valve, the flush being connected with an in-turned rim. By means

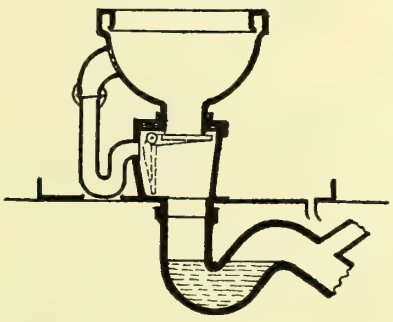


Fig. 6.

of a pull, the valve closing the 3-inch outlet of the basin is depressed into the enamelled iron box, and the contents are thus discharged through the short conducting pipe into the syphon trap with which the closet is connected. A lead overflow pipe, with syphon trap, connects the basin with the valve box, which should be ventilated by a pipe carried upwards through the wall to a convenient point where it may be cut short, the object being to guard against syphonage of the overflow trap, and provide a vent for any foul air which may accumulate in the valve box in the event of imperfect flushing of the closet trap through carelessness. In case of accident a *safe* or tray should be provided under the closet, with a waste-pipe carried through the wall to discharge into the open, a hinged flap being fixed at the end to prevent air from blowing through the pipe, which in winter may freeze the water in the closet pan, etc.

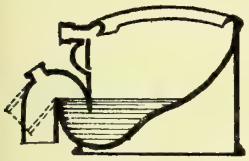


Fig. 7.

The wash-down closet requires little or no description, but it may be pointed out that the chief features in a good appliance are a large water area, a good depth of seal, and an outgo which allows of an efficient union being made with the soil-pipe. When such a closet is fixed on the ground floor the outgo should pass down to the floor, the extreme edge for about $1\frac{1}{2}$ in. being free from glaze, to allow of a cement joint being made with the drain, which should be carried upwards to the floor level in an easy curve. The outgoes in the case of some wash-down closets are encased in pottery, but this arrangement is to be condemned, as it is impossible in the case of such an appliance to form a water-tight union with the drain or soil-pipe, as the case may be. In the case of wash-down closets not on the ground floor, lead outgoes are now frequently attached securely to the earthenware by various patent processes, and thus the closet can be properly connected with the soil-pipe by means of a wiped joint. Previously considerable difficulty was experienced in making this connection, but the above invention has entirely done away with that.

The drawing (Fig. 8) represents a *trough closet*, which is frequently used for schools and factories. The flush in this case must be automatic, and the best tank for the purpose is Field's, which has already been described.

Mention must also be made of *slop water-closets*, of which there are many varieties, the slop water being utilised as a flush by means of an automatic arrangement in the shape of a tipper. Of course, such closets can only be fixed out of doors, and as compared with privies they are cleanly appliances, but they cannot be compared with ordinary water-closets from that point of view, and it is doubtful whether their introduction should be encouraged.

Lavatories, Baths, and Sinks.—The chief point to consider in connection with lavatories, baths, and sinks is the method of dealing with the waste. In all such cases the waste should be carried through the wall, to discharge on to a gully trap direct if on the ground floor, or into a rain-head communicating with a gully by means of a down pipe. It sometimes happens, however, that the latter plan is inexpedient, owing to proximity to windows, in which case the waste should communicate direct with the down pipe, which should be carried upwards as a ventilator. No matter which method is adopted, however, it is essential to fix a syphon trap immediately under the outgo, as merely disconnecting the waste outside is not sufficient. It frequently happens that

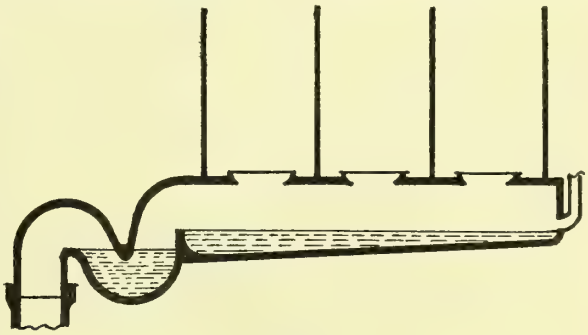


Fig. 8.

more than one lavatory, or a lavatory and a bath, has to be connected to a common waste, in which case each individual waste should be trapped, and, as the traps are likely to become unsealed from syphonage under such circumstances, antisyphonage pipes should be carried from the crown of each trap to join a main pipe,

which is carried up outside the wall to join the ventilator of the main waste pipe above the highest connection. Such an arrangement as applied to two lavatory basins is shown in the drawing (Fig. 9).

Excrement and Refuse Disposal.—Both the privy midden and pail systems must be con-

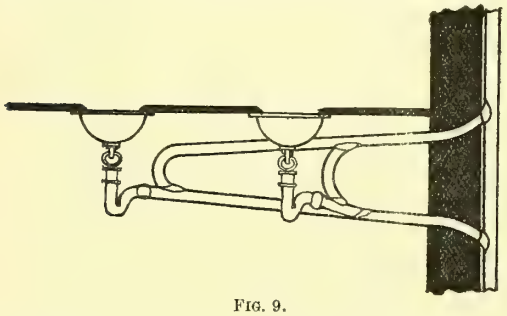


Fig. 9.

demned as being most insanitary in all urban districts, as well as in populous parts of rural districts, and the only remedy is the adoption of water carriage. In scattered rural districts, however, it may be necessary to recognise one or other of these systems, but in such cases the privies should be so constructed as to comply with every requirement set forth in the model Bye-laws of the Local Government Board. At the same time, however rigidly the Bye-laws may be adhered to, nuisance must arise from the storage of filth on any premises even for short periods, and, if water carriage is impracticable, undoubtedly the best alternative is the earth closet system, provided means can be devised to insure that an ample supply of dry riddled soil is always available.

As regards dry refuse, movable receptacles with, at least, weekly removal is the only satisfactory method for towns, and in some cases bi-weekly or even daily removal is desirable. In country districts, however, fixed receptacles may be allowed provided precautions are adopted to keep the contents dry, and it is well in such cases, if privies are in use, to apply the riddled ashes to the privy contents. As regards the ultimate disposal of the refuse, waste land is usually available in rural districts, or farmers are willing to remove the privy midden contents free of charge provided the ashes used are riddled; but the proper solution of this difficulty is to burn the dry refuse in destructors, a practice which, it is satisfactory to find, is becoming more and more general.

Sewage Disposal.—Before dealing with the methods of sewage disposal which are now generally adopted, it may be well to indicate what must be accomplished by all methods if success is to be achieved, and it will probably suffice to set forth the essentials in the form of a table:—

Essentials.

First Stage.	1.	The removal of all large suspended matters and inorganic solids, such as road detritus.
	2.	The removal or liquefaction of all solid organic matter in suspension.
Second Stage.	3.	The conversion of the inorganic matter present in solution into more stable (non-putrefactive) substances = *nitrification.*

No matter what method of disposal is adopted, the sewage must first undergo a process of screening and partial subsidence in order to hold back large floating matters and road detritus.

As regards the purification process proper, both in the disintegration of the organic constituents and the subsequent conversion of the unstable products into stable non-putrefactive substances, bacteria are the active agents. There is no such thing as the disposal of sewage by chemical methods; all that chemicals can effect is the mechanical precipitation of the suspended solids (in large tanks), leaving the dissolved organic matter to be dealt with by land or artificial filters as the case may be. It is true, the final biological changes effected by land or filters are greatly facilitated by the removal of the solids by chemical precipitation, but the resulting sludge has to be disposed of, and this presents many difficulties. Now, however, it has been established that the whole process of purification (unless in the case, possibly, of very exceptional sewages) can be effected by bacteria, and thus the difficult question of sludge disposal has been overcome.

Having regard, then, to what has to be accomplished, the following table sets forth the different methods which may be employed:—

Methods.

After subsidence of detritus:—

First Stage.	1.	Cameron's septic tank.	
	2.	Scott-Moncrieff's upward-flow cultivation tank.	
	3.	Large grain filters used as	(*a*) Filters.
			(*b*) Contact beds.
Second Stage.	1.	Land treatment	(*a*) Broad irrigation.
			(*b*) Downward filtration.
	2.	Small grain filters used as	(*a*) Filters.
			(*b*) Contact beds.

If chemical precipitation is adopted, the tank capacity provided should at least equal one-half to two-thirds the daily flow of sewage, and it is desirable in the case of large works to provide a plant for pressing the sludge, otherwise the difficulty in ultimately disposing of it will be considerable. But even when pressed into comparatively dry cakes the bulk of material to be handled is considerable, and, because of its low value as a manure, it is not always possible even to induce farmers to cart it away.

Now, however, in the majority of cases, there is no need to incur this large expense, as the first as well as the last stage in the treatment can be effected by one or other of the bacterial methods set forth in the table.

Cameron's Septic Tank.—This is a tank of sufficient capacity to hold from one to one-and-a-half day's sewage flow. The sewage, after straining and subsidence of the detritus, enters the tank a little below the level at which it stands in it, the overflow being similarly arranged; the object being to cause as little disturbance of the surface as possible, and thus allow of the formation of a thick scum which gradually becomes more or less solidified, until a comparatively firm permanent covering forms all over, thus excluding light and checking loss of heat. Under such conditions the anaerobic organisms multiply with enormous rapidity, and, the putrefactive process being correspondingly hastened, in the course of from twenty-four to thirty-six hours the solid organic matter is digested and liquefied, the nitrogenous portion being converted chiefly into ammonia, the carbonaceous into carbonic acid, and nitrogen, hydrogen, and other gases are evolved. The sludge difficulty, therefore, has been overcome, and the organic matter has been so altered in character as to allow of its being more readily dealt with by the aerobic organisms in the second or purifying stage proper.

In *Scott-Moncrieff's upward-flow cultivation tank* the sewage enters at the bottom, and, passing through large stones or flints with which the tank is filled, it discharges at the top, the theory being that the liquefying process is rendered more rapid and complete because the stones form a breeding-ground for the bacteria, which are thus brought into more intimate contact with the sewage as it slowly passes upwards. Experience seems to show, however, that the results obtained by either form of tank are practically identical.

Large grain filters, or, more correctly speaking, percolation beds, will accomplish the same objects, and it is likely that the process in this case is aerobic as well as anaerobic. The tank is filled with particles of some hard, non-friable material, and the sewage enters at the top and discharges at the bottom, an arrangement which, of course, involves loss of fall. There are two methods of working such a tank—it may be used as a filter (percolation bed), or what is known as a "contact" bed. In the former case the sewage is distributed over the surface and passes downwards in a continuous stream through the bed, whereas in the contact method the bed is rapidly filled, the outlet being closed, and the sewage is allowed to remain stationary in contact with the particles for, say, two hours, at the end of which time the outlet is opened and the sewage is rapidly discharged, the bed being allowed to remain empty for a like period. Various efficient means are available for the filling and emptying of the beds automatically.

With regard to the comparative merits of the above methods, all may be considered satisfactory; but, if the available fall is sufficient, probably the large grain filters worked on the percolation principle are the most satisfactory.

As regards the final or wholly aerobic stage of the treatment, in which the unstable products of the first stage are converted into more stable non-putrefactive inorganic salts, if suitable land is available and can be procured at a reasonable cost, there need be no difficulty, and the method which will yield the best results is *intermittent downward filtration*, the beds being thoroughly drained at a depth of at least five feet, and the liquefied or precipitated sewage being discharged over the surface by the ridge and furrow method. Unless the land is thoroughly satisfactory, however, it is pure waste of money to attempt to make it so, as the same result may be achieved by means of *fine grain filters.*

As in the case of the large grain beds used in the first stage, these may be worked on the "contact" method or as percolation beds, but as thorough aeration is the all-important object in the second stage there is no question whatever that percolation is superior to "contact." It is difficult, however, to devise means of distributing the sewage finely and uniformly over a large surface of filter, consequently the unscientific "contact" method is at present most in favour. No doubt this difficulty of obtaining uniform distribution will ultimately be overcome, and in that event the contact method will unquestionably become a thing of the past. Had the "contact" method not been introduced, the probability is that the difficulty of distribution would have been solved ere now; but with such a simple though less efficient alternative available, engineers have, unfortunately, shown little desire to solve the difficulty.

By a combination of the biological methods described it is now a comparatively simple matter to devise a plant for disposing of the sewage of individual houses or groups of houses in rural districts, and in such cases the percolation method of working the beds is easily provided for by a system of trough distributors.

Sewer-gas.—A mixture of noxious gases (ammonia and nitrogen or other forms, chlorine, etc.) generated in drains, and capable of setting up various maladies, such as tonsillitis (sewer-gas throat) and pneumonia (sewer-gas pneumonia). *See* Air, Examination of (*Sewer Air*); Sewage and Drainage; Tonsils, Diseases of (*Acute Tonsillitis, Causes*); Typhoid Fever (*Etiology*).

Sex.—The distinction between male (formerly called *sexus fortior* or *potior*) and female

(formerly called *sexus sequior*, the worse sex); it is of importance in relation to the incidence of disease, diphtheria attacking females more often than males, etc.

Sex-.—In compound words *sex-* (Lat. *sex*, six) means relating to six; e.g. *sexdigitism* (the anomaly in which six digits instead of five are found on a hand or a foot), and *sextan* (a form of malaria in which there is a paroxysm on every sixth day).

Sextuplets.—The occurrence of six at a birth; it is an extremely rare phenomenon in the human subject, but now and again a case is reported, *e.g.* Vassali's in the *Annali di ostetricia*, p. 343, June 1894.

Sexual.—Related to or belonging to sex; *e.g.* the sexual act (copulation), the sexual organs (male or female reproductive organs), sexual perversion (abnormal sexual feelings and instincts), and sexual diseases (maladies of the organs of generation). *See* Brain, Cerebellum, Affections of (*Tumour, Symptomatology, Sexual Functions*); Insanity, Nature and Symptoms (*Insane Defects of Inhibition, Nymphomania*, etc.); Generation, Female Organs of; Ovaries, Diseases of the; Prostate Gland; Scrotum and Testicles, Diseases of; Sterility; Syphilis; Tabes Dorsalis (*Etiology, Sexual Excesses*); Urethra, Diseases of; Uterus, Malformations and Diseases of; Vagina, Disorders of the; Vesiculæ Seminales; Vice.

Shadow Corpuscles. — Colourless erythrocytes or achromacytes of the blood; red blood corpuscles which have lost their colour by reason of endoglobular degeneration; Ponfick's corpuscles.

Shadow Test. *See* Retinoscopy (*Synonyms*).

Shaking Palsy. — Paralysis agitans. *See* Paralysis (*With Tremor, Paralysis Agitans*).

Shanklin. *See* Mineral Waters (*Chalybeate*).

Shapwells. *See* Balneology (*Great Britain, Sulphur Waters*).

Sharpey's Fibres. — Fibres in bone which connect the lamellæ in the walls of the Haversian canals.

Shearing. — The overlapping of the cranial vault bones of the infant during its expulsion from the mother's uterus; thus the depression of one of the parietal bones under the other is known as the lateral shear, while that of the occipital bone under the parietals is the antero-posterior shear; equitation or over-riding. *See* Labour, Mechanism.

Sheath.—A covering; *e.g.* the medullary sheath of nerves, the crural or femoral sheath, etc.

Sheep. *See* Anthrax (*In the Lower Animals, Sheep*); Foot and Mouth Disease (*Animals Attacked*); etc.

Shellfish. *See* Toxicology (*Food Stuffs, Shellfish*); Typhoid Fever (*Etiology, Food*).

Sheringham's Valve.—An inlet for air in the ventilation of a building, which is situated high up on the wall but not too near the ceiling, and which can be opened or closed at will. *See* Ventilation and Warming (*Vacuum System, Inlets*).

Sherrington's Law.—The fact that anastomoses are formed between the peripheral branches of the spinal nerve roots (anterior and posterior) in such a way that any region of the cutaneous surface is supplied with the branches of *three* roots.

Sherrington's Solution.—A diluting fluid for use in hæmocytometric observations, where the blood has to be diluted without the shape of the corpuscles being altered. It consists of distilled water, 300 parts; neutral potassium oxalate and sodium, of each 1·2 parts; and of methylene blue 0·1 part.

Sherrow Cautery. *See* Cautery (*Sherrow's or Paquelin's*).

Sherry.—Vinum Xericum, a Spanish wine used in Pharmacy to make nearly all the *Vina*. *See* Alcohol.

Shiga's Bacillus. — The bacillus dysenteriæ. *See* Dysentery (*Bacteriology*).

Shima Mushi.—The river fever of Japan. *See* Skin Diseases of the Tropics (*Constitutional Infective Diseases with Skin Lesions*).

Shingles. *See* Herpes (*Herpes Zoster*).

Ship Fever.—Typhus fever (*q.v.*).

Shippons. *See* Milk (*Milk Production, Cowsheds*).

Ships. *See* Cholera, Epidemic (*Prophylaxis, Disinfection of Ships*); Plague; Quarantine; Typhus Fever.

Shiver. *See* Rigor.

Shock.

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See also Abdomen, Injuries of (*Influence of Nervous System, Symptoms, Treatment*); Catheters, Uses and Dangers of (*Syncope*); Chorea (*Etiology*); Enemata (*Saline, in Shock following Hæmorrhage*); First Aid (*Shock and its Treatment*); Peritoneum, Acute Peritonitis (*Symptoms, Shock and Peritonism*).

The word "shock" is used in surgical literature to denote a state of prostration produced by abnormal excitation of the *peripheral* nervous system, and is thus distinguishable from "concussion," which follows direct force applied to the *central* nervous system.

"Syncope" and "collapse," often considered as special conditions, are in reality only degrees of shock, the former being the first symptom, and collapse the last, in a severe case. Some physicians prefer to use the term "collapse" for that condition of exhaustion brought about by chronic wasting diseases, severe toxic affections (*e.g.* typhoid fever, cholera), or poisons introduced from without.

A more comprehensive enunciation of "shock" would be—the arrest of some functions of the nervous system and a partial suspension of others, produced by afferent nerve impulses conveyed to the brain by the sensory and sympathetic nerve fibres. The impulses may be transmitted by:—

(1) *Nerves of special sense, e.g.* (*a*) the sight of a catastrophe; (*b*) the hearing of serious news, or heartrending shrieks; (*c*) the inhalation of irritating fumes into the nose.

(2) *Nerves of common sensation, e.g.* trauma by injury, heat, cold, or chemicals to any part of the body, the parts more highly endowed with sensation more readily resulting in shock —extensive superficial burns and crushes of the fingers may be instanced; and

(3) *Sympathetic nerves plus nerves of ordinary sensation, e.g.* injury to the thoracic or abdominal viscera.

The condition of the central nervous system has also to be considered in regard to

(1) *Sensitiveness to impressions:* emotional or nervous people, highly organised or highly civilised individuals being more susceptible than the phlegmatic or savage. It has been observed by physiologists that the more complex the nervous system of an animal, the greater the liability to and the intensity of shock.

(2) *Altered conductivity of the nerve fibres* and resistance of the nerve cells to impressions from (*a*) their inherent vigour; (*b*) intense concentration of mind: a soldier in battle may be seriously injured and yet continue fighting; (*c*) abeyance of function from anæsthesia, general or local, or from the action of drugs (*e.g.* alcohol and opium).

Symptoms.—In mild cases the patient feels momentarily faint, the skin turns a little pale, and almost as quickly again, as if by an effort of will or inhibition, recovers.

If severe, he staggers towards a seat or falls, the lips become livid or bloodless, the skin pale, and there may even be partial loss of consciousness. Respiration may be temporarily suspended, then reappear in shallow gasps, wanting the relief of sighs. The heart beats feebly and frequently, and the pulse of course likewise. Surface temperature is much reduced (although the rectal temperature may be only down a degree or two). A cold perspiration bespangles the brow, and the individual exists by reason of the automatic action of his two essential centres—the cardiac and respiratory—his irreducible minimum. The patient loses heat rapidly in ordinary surroundings, and the feeble circulation means feeble oxidation of the tissues and deficient interchange of oxygen and carbonic acid; continued exposure, particularly if the trauma be severe or continuous, will rapidly bring about a fatal result. Should the traumatism be severe, as in the crushing of a limb, or an electric shock of high voltage, the cardiac and respiratory apparatus may be immediately arrested, and death be instantaneous. In severe burn cases there is probably added a toxic element derived from the destroyed skin and blood, and we often notice gasping respirations, an intensely livid colour of countenance, paralysis of the sphincters, and rapid heart failure. If loss of blood be large, then we have in addition singing noises in the head, increasing pallor, rapid failure of pulse, great restlessness, and gasping respirations.

Signs of Recovery.—Increase of surface warmth, return of colour to the lips and skin, improvement in the volume and steadiness of the pulse. Respiration becomes deeper and fuller, often accompanied by deep sighs. The temperature of the body rises, and occasionally goes above normal, the patient becomes more conscious of his surroundings and his pain, he often vomits, particularly if the stomach has been full at the time of injury, and one of the first requirements asked for is "a drink."

Occasionally during apparent recovery, excitement and delirium supervene—the prostration with excitement of Travers; but careful investigation reveals either a previous history of alcoholism, some internal hæmorrhage, or septic complication. So-called traumatic delirium, except in the above conditions, is practically unknown.

Deferred shock is a term that has been loosely applied. That some patients from force of will power, or extreme desire to reach some haven of safety, can command strength to get there before collapsing, is well known. Again, individuals deeply alcoholised are met with so insensible to afferent impulses that they stump into the casualty room on the broken end of a tibia, often rendering a simple Pott's

fracture compound; but as the alcohol is eliminated, sensations travel better, and the symptoms and signs of shock appear. Generally, however, "deferred shock" must be looked upon as indicating concealed hæmorrhage, internal complications, or sepsis.

Pathology.—At a post-mortem examination of a fatal case of shock there is nothing characteristic. The heart may be arrested in diastole and the veins found fuller than usual. We must seek rather the aid of the experimental physiologist for an explanation of the phenomena of shock. Interference with the relation of the nervous system to the circulation of the blood offers the best explanation of most of the phenomena of "shock." The performance of the functions of the body depends on an efficient blood-supply, controlled by the vaso-motor system, under the guidance of a centre in the medulla. Repeated slight or severe afferent nerve impulses—in other words, a succession of nerve shocks—seriously inhibit the higher centres, the vaso-motor arrangement is readily disturbed, and the hold the nervous system has on the blood-vessels is temporarily suspended (reflex paralysis), leading to a general dilatation of the arterioles, particularly in the splanchnic (portal) area. A large influx of blood takes place into the abdominal viscera, draining the other parts of the body, producing anæmia of the systemic area and a general fall of blood pressure. Anæmia of the brain will be indicated by a failure of the higher faculties, will power, and temporary loss of consciousness, while deficiency of supply to the heart will bring about feeble action of that organ, or even arrest. That this effect is produced through the central nervous system is well illustrated in Goltz's well-known experiment of injury to the abdomen of the frog: marked cardio-inhibitory effect is brought about; but if the pneumogastric nerves be previously divided, the heart goes on beating normally. In shock as produced in an animal, the circulation becomes sluggish, blood pressure falls, the specific gravity of the blood becomes higher, and the interchange of oxygen and carbonic acid in the tissues is interfered with, hence the fall of temperature. Recuperative power is great, and if the irritation be removed and the body of the animal kept horizontal, or the head kept lower than the abdomen, the blood pressure quickly recovers and the symptoms and signs pass off. On the other hand, placing the animal in an upright position leads to a fatal issue by causing cerebral anæmia and heart failure. Loss of blood will exaggerate the shock and interfere with reaction.

Severe afferent currents produce molecular change in the nerve cells, inhibiting their function and leading to fatigue or even exhaustion. A powerful nerve current acts on the delicate nerve cell in a manner analogous to the effect an electric discharge of high voltage has on a delicate electrical instrument, completely disorganising it. This element of fatigue, exhaustion, or molecular destruction of nerve cell has to be largely reckoned with in shock, and must be borne in mind in the treatment.

To produce spinal shock it is essential that the cerebrum shall be in normal relationship to the spinal cord. The following interesting communication of Professor C. S. Sherrington demonstrates this:—

"Transection of the spinal cord of a dog at the lower cervical level causes a great fall of blood pressure. If this be not fatal, the blood pressure in the course of a few days regains its value to about three-quarters of what it was. In the course of a few weeks the pressure is gradually restored to normal height. If the animal is kept alive for three months, and then a fresh transection is made a segment or two below the previous one, the blood-pressure tracing now taken reveals no second fall of blood pressure at all, nor is the knee-jerk even temporarily depressed. Hence spinal transection *per se* does not produce spinal shock by mere trauma, the trauma being the same in the second as in the first section."

To sum up, the following factors contribute to the production of shock:—

(1) *Reflex paralysis*, acting (*a*) on the heart through the medulla, leading to a slowing or even arrest of the heart's action, (*b*) on the respiratory apparatus similarly.

(2) *Interference with the action of the vaso-motor apparatus*, leading to great fall in blood pressure, inspissation of the blood, and interference with the interchange of oxygen and carbonic acid in the tissues, and loss of animal heat.

(3) *Molecular change in the nerve cells*, bringing about fatigue or exhaustion of the nervous system.

(4) *Hœmorrhage.* Complicating the above we must remember that in most surgical injuries hæmorrhage occurs, influencing all the above changes.

Treatment.—*In slight cases*, without serious trauma, rest in the recumbent position and the administration of a diffusible stimulant is generally all that is required. A sniff of smelling-salts and a dose of brandy quickly bring about reaction.

In severe cases we have to consider the treatment of (1) the injury, and (2) the effects.

(1) We must endeavour by "first aid" to prevent further loss of blood, to remove the patient from the exciting cause; to extinguish the fire, if the clothing is aflame, and to promptly fix broken bones by any means at our disposal.

The establishment in large cities of horse ambulances, which are immediately dispatched to the scene of an accident on receipt of a telephone message, has done much to diminish

the "shock" of former days, when being roughly bundled into a cab and propped up in a corner was the usual method of conveying the injured to hospitals. Modern ambulances are fitted up with stretchers, and carry dressings and splints for all ordinary emergencies, and are sent out with a competent senior student or surgeon. Until the arrival of this hospital on wheels, the policeman on the beat—if a street accident—has rendered valuable first aid from the store of knowledge acquired by him from demonstrations and lectures conducted by the police surgeon. Hospital surgeons see daily the great good accomplished in this manner.

The patient is to be placed horizontally to allow the circulation of the blood to proceed with least impediment; if marked anæmia from loss of blood, the foot of the bed or couch should be elevated 6 or 12 inches. The quick removal of any tight clothing interfering with respiration, making free use of a scissors if necessary, exercising care not to expose a large surface of the body during undressing, and the avoidance of rough handling and shaking.

Warmth is to be applied in the quickest available manner, by wrapping in hot blankets, putting the patient to bed surrounded by hot bottles (bricks, flat-irons, or oven-shelves are often nearer to hand in private practice). Flannel wrung out of hot water over the precordia if the heart's action is very weak, and in some cases of severe burn where the clothing has been charred into the skin—immersion in a warm bath acts beneficially by its heat, and allows the burnt clothes to be removed.

Rest and quietness are important—the absence of noise and strong light, the prevention of worrying questionings by anxious friends, and the fussy interference of ubiquitous busybodies.

The administration of stimulants in the form of brandy or whisky in small doses diluted with hot water are most generally resorted to on account of their wide distribution. Sal volatile or ether serve the same purpose, but it must be remembered that absorption from the stomach may be at a standstill, and the injudicious administration of large doses often do more than distend the stomach and hamper the already feeble heart. The effect on the pulse must be carefully watched. The hypodermic injection of half a drachm or a drachm of ether, of $\frac{1}{100}$ gr. of digitalin, or, better still, $\frac{1}{30}$ or more of strychnine, produce good effects, and can be repeated in 20 minutes or half an hour if necessary. When the respiration is failing, atropine, gr. $\frac{1}{80}$, is often useful, and when great pain exists (*e.g.* "burn" cases), if the patient is able to swallow, an ounce of brandy with 15 or 20 minims of tincture of opium calms the excited nervous system and stimulates the heart. When great excitement, or fear of impending death, alarms the sufferer, the hypodermic injection of $\frac{1}{6}$ or $\frac{1}{4}$ of morphia hydrochlor. has a beneficial effect. In a recent case of bullet wound of the chest and feared injury of the heart, where the young man was in a terrible state of alarm, a dose of morphia put him to sleep, from which he awoke after a few hours wonderfully improved and calm.

In the use of hot normal saline solution we have the most powerful means of combating shock. A high rectal injection of a pint or two of hot saline solution (a drachm of common salt to a pint of hot water 105° to 110° F.) with or without an ounce of brandy and $\frac{1}{30}$ grain of strychnine, is at once absorbed, like water on a blotting-pad, and produces a more rapid effect than stomach medication. The pulse responds quickly, and the injection can be repeated hourly, or less often, as judged requisite. The injection may be made into the submammary and axillary connective tissue by hydrostatic pressure—using a funnel, tubing, and the needle of an aspirator, care being taken not to allow air to enter, but in extreme cases when circulation is feeble and absorption at a standstill, and particularly where there has been great loss of blood, the injection must be made directly into a vein—a superficial vein of the arm being generally chosen. An elaborate apparatus is not necessary; a cannula to fit the vein, two feet of rubber tubing, and a four-ounce glass male syringe with sterile gauze packing for the piston (instead of the worsted and dirty tow generally sold), being all that is necessary.

The apparatus is readily sterilised by boiling, the piston having been withdrawn, and the solution made sterile (for all practical—emergency—purposes, some boiling water may be poured on to the requisite amount of salt, or soloids made for the purpose, and cold water added until the right temperature is attained). The whole apparatus is filled with the solution before fitting the cannula into the exposed vein, to prevent, of course, the entrance of air. The cannula is tied into the vein, which is clamped or tied below, and the syringe elevated; if the solution does not flow in quickly enough, the piston is inserted and force applied to it. A finger and thumb clamp the tubing at the nozzle, and enable the syringe to be withdrawn to be filled again and reapplied, and this is repeated until 1, 2, 3, or even 4 pints have been injected. A doze of strychnine can be added if thought necessary. After an injection of one or two pints, if rallying occurs, we prefer to keep up the effect by rectal injections rather than repeat the intravenous operation.

Artificial respiration should be immediately resorted to when breathing has been arrested by shock from lightning, or electricity of high voltage, and continued for twenty minutes or half an hour—after which time it has not proved of any service. (*See also* "Asphyxia," vol. i. p. 305.)

When reaction has been established, nourish-

ment becomes essential, small doses of beef-tea, the white of egg beaten up, wine whey, and such easily assimilated foods to begin with, milk in some form as soon as it can be borne—a little at a time and often, and other additions when digestion seems re-established.

Treatment of Wounds.—Although a temporary dressing may have been applied, it is highly essential that the wound be thoroughly explored, disinfected and dressed, with a view to prevent further irritation, and to facilitate union by first intention if possible. Should the necessary manipulation be likely to cause increased pain and shock, an anæsthetic, local or general, must be used. Locally, eucaine or a concentrated solution of chloretone will enable a wound of small dimensions to be thoroughly explored, but if the injured tissues be extensive, a general anæsthetic becomes necessary, to enable thorough cleansing to be carried out and efficient treatment applied. Ether is the anæsthetic of choice in the majority of cases.

Operations during Shock.—In the shock attending a strangulated hernia, a ruptured bladder, or a severely lacerated limb, around which a tourniquet has been placed, very little time should be lost before effectively dealing with the cause. A few whiffs of ether act as a marvellous stimulant and anæsthetic, and the operation should be carried out with celerity.

From the brilliant, lightning-like rapidity of pre-chloroform days we are in danger in recent times, owing to anæsthesia, of dawdling over operations, from a common but erroneous notion that shock is not possible when a patient is anæsthetised, except from loss of blood. Every prolonged abdominal operation teaches the contrary: rough handling of the intestines produces marked depression; nerve currents still play, else how could the patient's heart and lungs keep going?

The patient must be well wrapped up in warm blankets, or cotton wadding bandaged on the limbs. If in pain, a hypodermic of morphia, or atropine if the respiration is feeble, should be given before the general anæsthetic. Many operations can, however, be carried out under local anæsthesia, Schleich's method, or eucaine.

A few well-chosen words of encouragement by the surgeon have often a marked good effect. The anæsthetic is best administered away from the scene of operation, amid quiet surroundings. The theatre should be well warmed—75° F. is not too hot. Many surgeons judge of the heat of a theatre by its effect on themselves: it can easily be too hot for the fully clothed operator, and yet too cold for a stripped and depressed patient. If possible, the operating table should be well heated by hot-water appliances fitted in, or a liberal supply of hot bottles conveniently arranged.

If there has been great loss of blood, saline injection may be employed before commencing, and in cases of fæcal vomiting, washing out the stomach is a very necessary preliminary.

During anæsthesia the patient should be horizontal, or, better still, the head and shoulders on a lower level than the abdomen, to allow gravity to compensate for loss of splanchnic vaso-motor tone. Experiments on dogs placed under anæsthesia demonstrate a marked fall of blood pressure and paralysis of the splanchnic vaso-motor tone, so that when the animal is placed in the vertical position, an alarming fall of general blood pressure is produced by the welling of the blood into the abdomen, recovering itself on changing the dog's position back again to the horizontal.

Undue exposure of the surface of the body is to be avoided; and rapidity, consistent with asepsis, and thoroughness, specially cultivated.

At the end of the operation, a quantity of hot saline solution left in the abdomen, or after amputations a pint or more injected into an exposed vein before final suture, acts as a tonic, by giving the heart a larger volume to contract upon, and providing a large addition of heat. The injection is often followed by a peaceful sleep, on awaking from which a feeling of elation and general well-being is often noticed.

After a serious operation, recovery is much facilitated by isolation, quietness, warmth, and the judicious use of stimulants, drugs, and saline injections (*see above*). When reaction is restored, discriminate feeding provides the nourishment to the harassed and fatigued nervous system and the depleted vascular system.

With all that surgery can suggest at our disposal we must be prepared to meet with failure in some cases, when (1) the injury in itself is necessarily fatal, (2) serious complications ensue, such as uncontrollable hæmorrhage, (3) a diseased condition of the patient's constitution prevents reaction, or (4) when extreme juvenility, extreme senility, or a general feebleness of the patient prevents recovery.

Prevention of Shock in Minor Surgery.—It is advisable to perform all minor operations, when a general anæsthetic is not required, with the patient lying down; syncope is then very rare. Local anæsthesia should be used whenever possible, and rigid attention paid to all the details of aseptic surgery. Such a proceeding as passing a catheter should be performed with all aseptic precautions: washing out the urethra, the use of a sterile instrument, and in very sensitive urethræ the preliminary injection of a drachm or two of a 2 per cent solution of eucaine (cocaine is dangerous); when these details are attended to, shock following catheterism will be hardly ever met with.

Shoemaker's Cramp or Spasm.

See Neuroses, Occupation (*Varieties*).

Shone's System.—A method of removal of sewage; it is a non-gravitation method

by which the sewage is lifted from a lower to a higher level by means of compressed air; it works automatically, the fall of the sewage into a chamber deeply placed in the ground ("ejector chamber") lifting a bell and opening a valve which admits the compressed air; it is in use in Eastbourne, Southampton, Cape Town, Rangoon, and elsewhere.

Short Sight.—Myopia. *See* Refraction (*Myopia*).

Short-Circuiting.—In Surgery, short-circuiting is an operation performed for intestinal obstruction, by which the pieces of intestine are approximated or implanted laterally.

Shoulder, Diseases and Injuries of.

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See also Amputations (*Shoulder Joint and Girdle*); Brachial Plexus, Surgical Affections of; Brain, Physiology of (*Motor Areas*); Chest, Deformities of; Labour, Operations (*Embryotomy in Shoulder Presentations*); Osteo-Arthropathies; Spine, Surgical Affections (*Scoliosis*).

The shoulder consists of the chief joint formed by the scapula and humerus, and of a joint of subordinate importance between the scapula and clavicle. It is liable to many diseases and injuries, partly owing to its exposed position, partly to the complexity of its structure, and

partly to the fact that it is one of the most movable joints in the human body.

Anatomy.—It is unnecessary to enter into full anatomical details, but certain peculiarities of structure may be pointed out because they have a direct bearing upon the pathology of the joint.

The shoulder is surrounded by muscles of great strength, except upon its inferior aspect. The capsule is so loose that when these muscles are all divided the humerus may be drawn away from the scapula for nearly an inch. The capsule is thicker above than below, and it is reinforced on all sides by accessory structures, externally by the coraco-humeral ligament, behind by the tendons of the supraspinatus, infraspinatus, and teres minor, in front by the subscapularis. The capsular ligament is perforated at three separate places, viz., at the lower part and in front by the long head of the biceps; behind, where the tendon of the subscapularis enters to attach itself to the lesser tuberosity, and by a less constant opening for the infraspinatus. The synovial membrane is for the most part simple in its arrangement, but it is prolonged through these openings in the capsule, the most complete prolongation extending along the tendon of the biceps, which it surrounds in such a manner that the tendon passes through the joint without opening into it. The actual articulating surfaces are neither large nor complete. They consist of the pear-shaped and slightly concave glenoid cavity of the scapula, upon which the ball-shaped head of the humerus moves freely. The joint is protected above by the bony arch formed by the union of the clavicle with the acromion, whilst on its inner side is the hooked process of bone called the coracoid.

The epiphyses are numerous and important, because the apparently simple shoulder girdle of man is formed by the fusion and remodelling of many parts which are separate in the lower vertebrates. The more important epiphyses in connection with the scapula are those of the acromion, of which the upper one may remain separate throughout life, and that of the coracoid process. In the humerus, the upper epiphysis forms the head of the bone, and its line of attachment is marked by the surgical neck in the adult. But this epiphysis is itself composed of a primary centre of ossification, marked by the anatomical neck, with which are fused the epiphyses of the greater and lesser tuberosities.

The superposition of bones, muscles, and muscular attachments at the shoulder leads to the formation of many bursæ. The chief of these bursæ are the subcoracoid, the subacromial, the bursa beneath the pectoralis major at its insertion, and the bursa between the tendons of the pectoralis major and the teres major. A large multilocular bursa lies beneath the deltoid, and there is a bursa beneath the infraspinatus, when there is no prolongation of the synovial membrane of the joint at this spot.

The axilla lies on the inner aspect of the joint, and its contents have to be reckoned with in all injuries and many diseases of the shoulder. The space contains the vessels and nerves which connect the trunk with the arm, enclosed in loose connective tissue, in which are embedded the lymphatic glands. The axillary space is closed below by the dense axillary fascia. The connective tissue running in front of the vessels and nerves as they pass through the axilla, is thicker and denser than in other parts of the space. It is called the suspensory ligament, and is attached to the clavicle above, enclosing the subclavius muscle. It then forms a sheath for the pectoralis minor, and afterwards blends with the axillary fascia, which it supports, and renders concave downwards. It often opens out just before it joins the axillary fascia to form a little pocket, in which lie three or four of the largest axillary glands. The suspensory ligament is important in operating upon cases of cancer of the breast, for if it be removed entire, the infraclavicular, the pectoral, and most of the subscapular group of glands will also be removed, as they are closely attached to it. The axillary fascia often presents an opening which resembles the saphenous opening in the thigh. It transmits the intercosto-humeral nerve, and the long thoracic artery. An axillary abscess may find its way to the surface through this opening or weakened portion of the fascia, which is situated midway between the anterior and posterior folds of the axilla, just at the inner margin of the hair which grows in the armpit, but such an abscess more often burrows towards the apex of the axilla.

The large axillary vessels and nerves lie in the outer wall of the axilla; the long thoracic artery runs along the anterior wall; and the subscapular, the dorsalis scapulæ, and the posterior circumflex vessels are closed to the posterior wall. The line of safety, therefore, in opening an axillary abscess runs from the centre of the axilla, not too near the apex, along the inner or thoracic wall of the space.

Bursal Enlargements.—The bursæ near the shoulder joint are numerous, and in some cases, as has been shown, are in reality prolongations of the synovial membrane. They may be acutely or chronically inflamed. The acute inflammation may result from sprains or blows; the chronic inflammation is nearly always tuberculous. Osteoarthritis has often been assigned as a cause, but inoculation experiments with the fluid obtained from such bursæ will nearly always demonstrate the presence of tuberculous infection. I have seen syphilitic enlargement of the bursæ near the shoulder in a few cases.

Treatment.—In the simpler cases the arm should be kept at rest, and evaporating lotion or

lead lotion may be applied, or the skin over the enlarged bursa may be painted with liniment of iodine. It is not unusual for the acutely inflamed bursæ of worn-out Londoners to suppurate, and the abscess must then be opened freely, and afterwards treated in the usual manner. I open tuberculous bursæ at once, evacuate their contents, and take every precaution to obtain union by first intention; for if failure occurs the joint is very likely to become involved, and a serious arthritis is set up. The prognosis is not very good in tuberculous bursæ. The inflammation often heralds an arthritis, but the bursæ sometimes become affected after the joint is involved.

Congenital Defects.—Three kinds of congenital defect in the shoulder have come under my notice from time to time.

Persistent Suprascapula.—The scapula is occasionally fixed immovably to the vertebral column, by a bridge of bone which passes from the posterior border of the shoulder blade to the lower cervical vertebræ. The condition is usually associated with lateral curvature of the spine, and with a considerable elevation of the shoulder on the affected side. The bridge of bone appears to be an abnormal development of the suprascapular epiphysis, which usually exists as a narrow ridge of bone along the posterior border of the scapula. It represents, therefore, the suprascapula, and is an instance of a reversion in the human shoulder girdle to a type which is only found in the lower vertebrates. Satisfactory results have followed its removal.

Obstetric Infantile Paralysis, or Erb's Paralysis, sometimes occurs in children born after a hard or protracted labour, even when forceps have not been used. Soon after birth the arm is found to be unduly sensitive and partly paralysed, for it is held in a position of slight abduction and full pronation. Little by little some use is gained in the arm, but the growth of the limb is retarded, some of the muscles, and especially the deltoid, waste, and the shoulder looks as if it had been dislocated backwards. Complete recovery is uncommon. The condition is due to stretching or injury of the fifth and sixth cervical nerves before they take part in the brachial plexus, so that the deltoid, the biceps, and the supinators of the forearm are most affected.

Treatment.—The arm should be kept at rest so long as it is swollen and painful. Massage and passive movements, especially in the direction of supination, should then be carried out, and the child should be put through a course of electrical treatment.

Stunted Humerus.—The epiphyseal line at the upper end of the humerus undergoes a remarkable change both in sporadic cretinism and in achondroplasia. In sporadic cretinism the proliferation of cartilage ceases early, and an ingrowth of fibrous tissue separates the epiphysis from the diaphysis. In achondroplasia (*see* vol. i. p. 39) a similar series of changes take place in the bones, but much earlier in fœtal life than those which occur from sporadic cretinism. The humerus is very short, and is often curiously thickened in both conditions, which are distinguished the one from the other by absence of mental defects, and atrophied thyroid in those affected with achondroplasia.

Contusions.—The exposed position of the shoulder renders it particularly liable to injury from blows and falls. Severe contusions often present symptoms which are out of all proportion to the signs, for the joint remains painful and motionless for many days, although it can readily be moved passively. In some cases the deltoid is temporarily paralysed, and there is so marked a flattening beneath the acromion that the joint appears at first sight to be dislocated. I prefer to treat these cases by massage and gentle passive movement, as soon as the first symptoms of acute inflammation have subsided, rather than by the older method of a shoulder cap and rest.

Dislocations.—Dislocations of the humerus are amongst the commonest accidents a surgeon is called upon to treat: dislocation of the outer end of the clavicle is one of the rarest. Dislocations of the humerus are either traumatic, paralytic, or congenital Traumatic dislocations are very rare in children and in young adults up to the age of 20. They increase in frequency from 20 to 60, and afterwards become less common as age advances.

Causes.—Comparatively slight accidents are sufficient to produce a dislocation of the humerus. A blow on the upper end and outer surface of the humerus, a slip with the arm abducted, a fall upon the elbow or hand when the arm is thrown behind the body are all well recognised causes. But even such trivial accidents as an awkward movement or a sudden muscular contraction may produce a dislocation of the arm, especially in those who have already suffered such an injury on a previous occasion.

Pathology.—Although the anatomical arrangement of the shoulder joint does not allow of so rigid a classification of dislocations as in the case of the hip (vol. iv. p. 224), the position of the head of the humerus usually occupies certain definite positions when it has been displaced from the scapula. The head of the humerus generally leaves the capsule at its lower part, so that it lies below the glenoid cavity and upon the front of the scapula to form *a subglenoid dislocation.* By the action of the muscles attached to the upper end of the humerus, or by subsequent movements of the arm, the articular surface of the humerus passes forwards and a little upwards, until it lies upon the neck of the scapula in front of the glenoid

fossa, and immediately below the coracoid process. An examination of the shoulder by the surgeon some time after the accident shows the bone lying in this position, and *the subcoracoid* is therefore considered to be the commonest form of dislocation of the shoulder. In some cases the inward movement may have been greater than usual, and the head of the bone passes along the inner side of the coracoid process until it comes to rest beneath the clavicle forming the rare *subclavicular dislocation*, when the axillary vessels and nerves are in danger of compression. In all these dislocations the capsule is torn at its inner and lower part, with corresponding injury to the circumflex nerve, the posterior circumflex artery, and the subscapularis muscle. The outer and upper portions of the capsule may remain uninjured, but the supraspinatus, the infraspinatus, and the teres minor may be torn from their attachments to the great tuberosity, or the great tuberosity itself may be torn off the humerus. The long head of the biceps may be displaced from its groove, but it is not usually torn through, or otherwise injured, and the head of the humerus is often deeply grooved at its posterior part by the sharp edge of the glenoid cavity. Sometimes the head of the humerus passes still more inwards until it lies beneath the clavicle forming the *subclavicular* variety, and still more rarely when the coracoid process is broken off at the time of the accident, the head of the humerus may lie upon the scapular fragment to form *the supracoracoid dislocation.* The head of the bone sometimes passes backwards instead of forwards, either by a secondary movement, or as a primary dislocation when the capsule is torn on the outer side of the joint. It then lies upon the outer edge of the glenoid fossa, or beneath the spine of the scapula to form the rare *subspinous dislocation.* Still more rare are the upward dislocations, when the head of the humerus is forced up between the coracoid and the acromion until it lies above the clavicle—*the supraclavicular* form—and the downward displacement produced by forcible elevation of the arm above the head, until the head of the humerus is displaced so far downwards that the arm maintains its upright position, forming *the luxatio erecta.*

Signs and Symptoms.—Although dislocations of the shoulder are so common, it is perhaps more often overlooked than any other injury except a broken collar bone in children. This is due partly to the fact that the patient does not apply for advice until some time after the injury, which he considers to be a bad sprain or bruise, and partly because the signs are somewhat more apparent at a distance and as a whole, than when the shoulder is examined closely but with some carelessness of detail. It is important, therefore, that a patient should be stripped to the waist when he comes complaining of a painful and fixed shoulder after an injury. He should sit in a good light at some little distance from the surgeon, with his arms in a similar position on the two sides. The surgeon should then compare the outline of the shoulders from the back, from the front, and from the sides, before he touches his patient. He can hardly fail to notice that the head of the bone is absent from the normal position, and is lying at some other point. In the ordinary subcoracoid dislocation the shoulder is depressed on the affected side, and the acromion projects more markedly than on the sound side. The arm is held away from the side, so that its long axis is directed towards the coracoid rather than towards the acromion. This alteration in the axis of the arm stretches some of the fibres of the deltoid, which are thus brought into undue prominence, causing the shaft of the humerus to appear as if it were bent inwards just below the insertion of the deltoid. The arm, too, looks longer on the affected side, because the head of the bone lies below its normal position when it occupies the glenoid cavity. The anterior fold of the axilla looks fuller than that on the opposite side, for the pectoral muscle is raised by a rounded swelling which partly effaces the subclavicular fossa. The head of the bone can always be felt in its new position, and both active and passive movements of the shoulder are much hampered at the shoulder, for the patient is unable to place his hand on the top of his head, or to put the injured arm behind his back. *Duga's test* is founded on this limitation of movement. It consists in placing the hand of the dislocated side on the opposite shoulder. If the shoulder be really dislocated the elbow will be elevated, and will stand out prominently in front of the chest, and no force applied in moderation will bring it flat against the sternum. Another test consists in applying a flat ruler to the outer border of the humerus from the external condyle to the acromion. If the head of the bone lies in the glenoid cavity the ruler will stand out three-quarters of an inch, or more, from the tip of the shoulder; but if the head of the humerus is displaced inwards either by dislocation of the head or fracture of the neck, the ruler will rest against the acromion. Both these tests, though they are widely used, are open to fallacy—in the one case, from fear rendering the muscles round the shoulder rigid; in the other, from an undue amount of swelling. I prefer, therefore, to trust to the general characters given above, assisted by the use of the X-rays when there is any unusual difficulty or doubt.

Differential Diagnosis.—Severe contusions of the shoulder and paralysis of the deltoid may be mistaken for a dislocation, though the converse mistake is the more common. In these cases the surgeon should assure himself that the head of the bone is really in its natural position.

Fractures of the neck of the scapula, of the acromion, and of the neck of the humerus may be mistaken for a dislocation of the shoulder. The occurrence of crepitus, and the recurrence of the deformity should the surgeon have endeavoured to replace such an injury by manipulation, will be sufficient to point out the true nature of the case.

Prognosis.—In the simpler cases the prognosis is good, as the patient generally recovers the full use of his arm, but even here it is well to test the action of the deltoid and the cutaneous sensibility over the shoulder on the day after reduction, for the circumflex nerve is often bruised and may be paralysed. From these simple cases a dislocation passes through every grade of severity. It may be complicated by pressure on the axillary vessels and nerves leading to serious after-effects. There may be a coincident fracture of the neck of the bone, or the dislocation may be associated with a lacerated wound rendering it compound. In one or two instances I have seen serious hæmorrhage, due to laceration of the axillary vein and of the posterior circumflex artery.

Treatment.—Reduction is the only proper treatment for a dislocated shoulder, and this should be performed immediately. If it can be done at once, whilst the muscles are still relaxed from the effects of the shock, the head of the bone can usually be replaced without trouble. But they soon become fixed by tonic contraction, and more skill is then needed. The surgeon takes a great responsibility upon himself who waits even one night before he reduces a subcoracoid or subglenoid dislocation of the shoulder, for the head of the bone is pressing upon the axillary vessels and nerves, often with disastrous results.

As a general rule it is hardly safe to attempt to reduce by manipulation a shoulder which has been dislocated for more than six weeks, and the older the patient the less is the surgeon inclined to meddle with such a case. Very serious accidents have occurred during attempts at reduction, and it is wiser, therefore, in long-standing dislocations to cut down upon the head of the bone, and then to replace or excise it.

Reduction.—The obstacles to reduction are the untorn capsule at the upper and outer part of the joint, and the tonic contraction of the pectoralis major and latissimus dorsi muscles. But the scapula moves so freely upon the thorax that dislocation of the shoulder is not subject to the same rigid rules of reduction as is the case in the hip (vol. iv. p. 224). Two methods of reduction are in common use, viz. Kocher's method by manipulation, and Sir Astley Cooper's plan of extension. Both methods have their advocates, and I have obtained equally good results from both. Kocher's method is perhaps rather better fitted for old and delicate people; Astley Cooper's for young and muscular adults.

Kocher's Method.—The patient is seated, and the surgeon stands facing him and upon his injured side. He bends the elbow, and grasps it in one hand whilst he seizes the wrist with the other. He then bends the elbow, and adducts the arm until the elbow touches the trunk. The arm is immediately rotated outwards as far as it will go, and being thus adducted and rotated outwards the elbow is carried well forwards and upwards. The whole arm is then rotated inwards, so that the hand sweeps over the chest whilst the elbow is brought back to its original level. The bone slips into place with a hardly perceptible click in a successful case, and the shape and movement of the joint are at once restored. No violence should be used, and the manipulation must be done in an orderly fashion. It is not usually necessary to administer an anæsthetic.

Dr. Helferich explains the effects of the movements in the following words: "During the adduction of the arm the upper part of the capsule is stretched, and the head is pressed against the edge of the glenoid cavity, so that the later rotation turns it on this part of the scapula and not round its own axis. When the arm is elevated the coraco-humeral ligament is relaxed, and the head begins to pass through the rent in the capsule. The inward rotation completely replaces the head of the bone within the capsule.

Sir Astley Cooper's Method.—The patient lies upon a firm bed or couch, stripped to the waist. The surgeon removes his boot from the right foot for the right shoulder, and from the left foot for the left shoulder. He then sits facing the patient, and on a level with his knees, places his unbooted heel in the axilla of the injured side, grasps the wrist or humerus, and pulls steadily upon the arm, at the same time carrying the limb towards the middle line of the body, and pushing the upper end of the humerus into place with his heel. A roller towel attached to the patient's arm with a clove hitch, applied just above the condyles of the humerus, is sometimes a great help in muscular patients, or in those with fat and heavy arms.

After Treatment.—It is sufficient to keep the arm at rest by fixing the hand to the opposite shoulder with a bandage, whilst a cooling lotion is applied to the injured part. Passive movements should be commenced at the end of a week, and in simple cases the arm should be set free within a fortnight. But no dislocation should be allowed to go unreduced, and the surgeon is bound to effect reduction even by operative measures, when manipulations have failed, for unreduced dislocations of the shoulder result in very painful and useless joints.

Irreducible Dislocations.—A certain number

of dislocations are irreducible in the sense that the head of the bone cannot be replaced by the ordinary methods of manipulation.

The coexistence of a fracture of the upper end of the humerus with a dislocation of the shoulder is a not uncommon cause of irreducibility. The method of treatment in these unfortunate cases has varied greatly. It used to be the rule to wait until the inflammatory process had subsided before the head of the bone was excised, and this rule is still a good one to follow if the surgeon does not see the patient until some time after the accident, or if he is unable to operate immediately. But if the patient be seen at once and the operation is not delayed, it is better to cut down upon the front of the joint, reduce the dislocation and wire the fracture, before the tissues have become softened and infiltrated.

The difficulty in reduction is sometimes due to the capsule being detached from the scapula rather than torn through as is usual, and in old-standing dislocations the condition of the capsule is one of the commonest causes of the impossibility of reduction, whilst in other cases the muscles become sclerosed and shortened, or the head of the humerus is altered in shape. These cases are also best treated by arthrotomy and replacement of the head if possible. Resection must be performed when the humerus cannot be replaced without undue difficulty. It is most important in the case of children that the epiphyseal cartilage should not be injured, and only the ossified portion of the head should be removed, the epiphyseal cartilage being carefully spared. The resected end of the humerus too should not be pushed into the glenoid cavity, lest the growth of the bone should cause anchylosis. In adults, on the other hand, it is the rule to push the resected end of the bone into the glenoid cavity when regeneration of the bone is expected. The operation of resection or excision of the shoulder is described on p. 157.

Secondary Dislocations of the Shoulder

Secondary dislocations are either associated with paralysis of the deltoid and scapular muscles, often due to poliomyelitis, or they are seen after destructive inflammation of the joint, and as recurrent dislocations they occur after traumatic dislocations as a result of causes which are too slight to displace a normal joint. The causes of habitual dislocation are many; the chief causes being laxity of the capsule of the joint, partial fracture of the head of the humerus or of the glenoid cavity, tearing away of the muscular insertions, rupture of the tendons around the joint, and abnormalities in the shape of the head of the humerus, probably the result of chronic non-suppurative inflammation.

The treatment of recurrent dislocations of the shoulder joint should be by massage and exercises. The exercises should be made against resistance, and should be especially directed to the development of the atrophied muscles. Abduction of the affected arm will cause contraction of the deltoid, whilst a course of electrical treatment will assist in causing them to contract. The shoulder should be shampooed daily, and the treatment should be continued for three months. If the dislocation recurs at the end of this time, an operation may be performed to expose the front of the capsule, which is then resected and shortened by the insertion of sutures.

Rupture of the Biceps Tendon

May result from any of the accidents which usually cause dislocation of the shoulder. The head of the humerus is drawn upwards and forwards in its socket until its further progress is stopped by the acromion and coracoid processes and by the coraco-acromial ligament. The condition was known at first as partial displacement of the long head of the biceps—though there is no pathological evidence to show that such displacement ever occurs without rupture—and afterwards as partial displacement of the head of the humerus, in the belief that the capsule in such cases was stretched, but not torn. The treatment is the same as for ordinary dislocations of the shoulder, viz. reduction and subsequent rest of the joint.

Dislocation of the Acromial End of the Clavicle

The acromial end of the clavicle may be dislocated alone or simultaneously with the sternal extremity, and the displacement is either incomplete or complete according as the acromio-clavicular ligaments alone are ruptured, or both the acromio-clavicular and the coraco-clavicular ligaments are torn. The condition is painful, and the attitude of the patient is similar to that assumed in a broken clavicle, for the patient supports the elbow of the injured side with the uninjured hand, whilst he bends his head towards the affected shoulder. The abnormal projection of the collar bone on the affected side is very evident, the arm falls towards the chest, and the cavity of the axilla is diminished, whilst the head of the humerus and the acromion are less prominent than on the sound side.

Treatment.—Reduction may be difficult owing to the acromial end of the clavicle becoming entangled in the anterior fibres of the trapezius, but usually it is as easy to replace as it is difficult to keep the two bones in apposition. The treatment generally adopted is to bend the elbow to a right angle, and then carry a long strip of adhesive plaster, three inches wide, under the forearm close to the olecranon, bringing the ends along the front and back of

the arm to cross over the end of the clavicle, and adhere to the chest wall in front and to the scapula behind. The forearm is then supported in a large arm-sling (vol. i. p. 361), and the arm is bound to the side with a bandage. When the method fails, and there is much loss of function or great deformity, no hesitation should be felt in uniting the outer end of the clavicle to the acromion with a stout silver wire.

Fractures

Fracture of the scapula, humerus, and clavicle occur in the immediate neighbourhood of the shoulder at all ages and in both sexes.

Fractures of the Acromial End of the Clavicle.—The outer end of the clavicle may be broken between the conoid and trapezoid ligaments or external to the trapezoid. Fracture between the ligaments is a rare accident, accompanied by pain and crepitus, but without any displacement of the two fragments. Fracture beyond the coraco-clavicular ligament is more common, and there is considerable displacement. The fragment attached to the scapula is drawn downwards and inwards by the weight of the shoulder, and action of the muscles attached to the shoulder until it may even unite at a right angle with the rest of the clavicle.

Treatment.—A simple sling with a piece of lint soaked in some evaporating lotion should be sufficient when there is no displacement, but when the displacement is marked and is not remedied by the application of Sayre's method of strapping the arm (vol. iii. p. 351), the fragments should be wired together.

Fractures of the Scapula.—The scapula in the neighbourhood of the shoulder may be broken at the neck or at the edge of the glenoid cavity; the acromion may be fractured or the coracoid process may be broken. Fractures of the neck and edge of the glenoid cavity have been usually associated with dislocation of the shoulder, for which they may be easily mistaken.

Treatment.—There is but little to be done for these injuries except to reduce the dislocation under an anæsthetic, to keep the arm at rest, and to protect it from accidental injuries by the use of a shoulder cap, a small axillary pad often being serviceable in supporting the shoulder.

A fractured acromion is recognised by the flattening of the shoulder, the depression of the arm, and the interruption in the bony ridge which it forms with the spine. It should be remembered, however, that some at least of the apparently ununited fractures of the acromion are in reality instances of epiphyses which have never been united to the bone.

Fracture of the Coracoid Process.—The coracoid process is not often broken, but it may be fractured by direct violence, by dislocation of the head of the humerus upwards and forwards, by extreme flexion of the shoulder joint when the coracoid is brought into forcible contact with the under surface of the clavicle, by sudden muscular action, and even by falls upon the elbow. There may not be much displacement, or the broken fragments may be widely separated, being drawn downwards by the action of the muscles attached to it. Bony union takes place when the parts can be kept in apposition.

Treatment. — The forearm should be fully flexed, the arm being brought forwards over the chest wall and secured in position by strapping, whilst a pad is placed over the acromial end of the clavicle.

Fractures of the Humerus.—Fractures of the upper end of the humerus are more frequent and more important than those of the scapula. They may be divided broadly into the rare intracapsular fracture through the anatomical neck of the bone and the extracapsular fracture through the surgical neck. The actual line of fracture, however, is usually so irregular that it is partly within and partly outside the attachment of the capsule. Either form of fracture may be impacted.

Causes. — The cause of the fracture is generally a direct blow or fall upon the shoulder, though it is sometimes produced by indirect violence, as by a fall upon the elbow or hand. It is more common in middle-aged and old people than in children or young adults.

Pathology.—The fracture is situated above the attachment of the large muscles into the shaft of the humerus, and the upper end of the lower fragment is therefore drawn upwards and inwards towards the coracoid process, whilst the head and neck of the bone is abducted and rotated outwards.

Signs and Symptoms.—The pain is often well localised owing to pressure upon the nerves, and there may be great and rapid swelling of the shoulder due to hæmorrhage from laceration of the circumflex arteries. There is but little deformity in the immediate neighbourhood of the shoulder, for the head of the bone is in its place and bears the normal relation to the acromion, but it is difficult to feel the coracoid. The arm hangs nearly vertical, and when the elbow is brought to the side the hand on the injured side can be made to lie on the opposite shoulder, thus distinguishing the injury from a dislocation. There is a shortening of three-quarters to one inch in the measurement from the acromion to the external condyle on the injured side. Crepitus can be elicited by firmly grasping the head of the bone and rotating the elbow. The diagnosis from symptoms is very obscure in cases of impacted fracture, as, except for the shortening, the other signs are absent. The radiograph, however, is of use in these injuries.

Treatment.—The treatment consists in applying a bandage to the hand and arm. A small pad of wool powdered with zinc oxide or starch is then placed in the axilla, and the elbow is carried well across the chest to counteract the inward displacement of the lower fragment. It will sometimes be found advisable to mould a guttapercha shield reaching from the middle of the clavicle to the upper part of the forearm, which is flexed at a right angle, and sufficiently large to fit the outer, anterior, and posterior aspects of the limb. Passive movements should be commenced on the fourteenth day in simple cases.

The prognosis is good, but a dislocation may be combined with the fracture, and the upper fragment may be so twisted that it can only be replaced by manipulation when the patient is under an anæsthetic.

Separated Epiphyses. — *Anatomy.* — The upper end of the humerus is developed from three centres which blend with each about the sixth year, and form the fully ossified head at the age of puberty. The three centres are one for the head, one for the great tuberosity, and one for the lesser tuberosity. The united upper epiphysis is cup-shaped, and includes the two tuberosities, the upper fourth of the bicipital groove, the whole of the head and anatomical neck, as well as a very small portion of the bone external to the lesser tuberosity.

Pathology.—The whole upper epiphysis may be separated with or without displacement, or the great tuberosity may be detached separately. Separation of the whole epiphysis occurs most frequently between the ages of ten and fifteen, though instances are recorded from birth up to twenty-five. It is produced by falls or blows upon the shoulder, and when the whole epiphysis is detached the violence is often sufficient to make the injury compound. The diaphysis is either completely or incompletely separated, and when it is complete the end of the shaft may be displaced in any direction.

Signs and Symptoms.—The arm hangs helpless against the side of the body, with the elbow drawn slightly away and projecting backwards or downwards according to the displacement. There is abnormal mobility just below the shoulder joint, so that the arm can be brought close to the side, and passive movements are free though painful. There is often great pain, and the swelling is rapid and considerable, involving the whole of the shoulder and the upper third of the arm. The shoulder is increased in width antero-posteriorly, and the head of the bone occupies its normal position. There is muffled crepitus, and the arm is not materially altered in length.

Differential Diagnosis.—The separation of the whole upper epiphysis has to be diagnosed from a dislocation, which is one of the rarest accidents in children, from true fracture of the surgical neck, from separation of either tuberosity, and from sprains and contusions.

Prognosis.—The prognosis is good in the simple cases, though there may be some arrest of development, but there is often so much stripping of the periosteum from the shaft of the humerus that periostitis and necrosis may take place. This separation of the periosteum forms an additional danger in compound injuries, which I have seen followed by rapid death from pyæmia.

Treatment.—The patient should be anæsthetised, and the diaphysis should be methodically replaced by steady traction upon the arm aided by slight abduction and rotation. Splints should then be applied, and the shoulder treated as if for a fracture, by flexing the forearm and bringing it forwards so that the fingers lie upon the opposite shoulder. This carries the elbow well across the chest, and the injured arm is then fixed securely by a broad flannel bandage. Some means of extension may be employed advantageously in older children. Massage, supplemented by a judicious use of electricity, will be of great service when there is loss of power with muscular atrophy. It should be commenced about the beginning of the third week after the accident.

It is sometimes impossible to reduce the displaced upper end of the diaphysis, and in these cases, when there is great displacement, deformity, and interference with the movements of elevation and rotation of the shoulder, the question of excision of a portion of the bone may be advantageously considered, with or without subsequent wiring.

Separation of the Tuberosities.—The great tuberosity is usually torn off by direct violence, though it has been detached by muscular force. The tubercle is drawn upwards and backwards towards the back of the acromion process, whilst the shaft of the bone is pulled upwards and inwards.

Symptoms.—These changes in position lead to a great widening of the shoulder, which is best seen by looking at the patient sideways or from behind, and there is a marked prominence of the coracoid process on the injured side. The separated epiphysis can often be taken between the finger and thumb, and can be moved into its natural position, and if the arm be extended at the same time, the deformity is temporarily overcome.

Treatment.—The best results are obtained by putting the patient to bed, raising the arm above the head, and securing it in such a position that the greater tuberosity lies over its point of separation. When from any reason the patient cannot be kept in bed, a guttapercha or leather cap should be moulded to the shoulder, and fitted on its inner surface with a pad to retain the great tuberosity in position.

The lesser tuberosity of the humerus may

also be detached, but I have not yet seen a case. Some surgeons treat both these injuries by wiring the detached fragment of bone to the humerus.

Separation of the Coracoid Process.—The entire epiphysis of the coracoid process may be separated, or only the small apical portion which has a separate centre of ossification. The whole coracoid process cannot be separated as an epiphyseal injury after the seventeenth year. The accident is usually the result of very severe violence applied directly to the front of the shoulder.

Symptoms.—The symptoms are pain over the coracoid process, inability to raise or adduct the arm in consequence of interference with the attachment of the biceps and coraco-brachialis muscles, abnormal mobility of the detached process, and muffled crepitus. The injury may be complicated with dislocation or fracture of the humerus, or with dislocation of the outer end of the clavicle.

The *treatment* consists in keeping the arm and forearm fully flexed to relax the muscles attached to the coracoid process, whilst the elbow is supported and the whole arm on the injured side is bound to the chest.

Inflammatory Conditions.—The shoulder is not especially liable to inflammation, and the war in South Africa has shown that it may be very severely injured without great or permanent interference with its function.

Simple Inflammations.— *Wounds.*—My colleague, Mr. Bowlby, lately surgeon to the Portland Hospital, says that most of the bullet wounds involving joints healed without difficulty in the South African campaign, and gave rise to but little synovial effusion. Thus, a gunner shot through the right shoulder joint from front to back was able to return to his battery in five weeks' time, passive movements having been commenced about fourteen days after the injury. The results in civil life, however, are somewhat less satisfactory, for a wound involving the joint usually suppurates.

Simple Synovitis.—Cold, overuse, and direct injury are the common causes of simple synovitis of the shoulder. The painful effusion is easily controlled in a healthy person by resting the joint and avoiding the cause.

Sprains.—The game of hand fives is sometimes responsible for a peculiar sprain of the shoulder which involves the supraspinatus, the infraspinatus, and the triceps muscles, causing a good deal of pain down the arm.

Infective Inflammations.—The inflammations of the shoulder due to micro-organisms and their products are numerous, and may be severe. Rheumatism, scarlet fever, and more rarely typhoid, cause synovitis of the shoulder, which is either serous, plastic, or suppurative.

Acute osteomyelitis sometimes begins near the epiphyseal line of the head of the humerus. It occurs in delicate children often after a slight injury, and when they have recently recovered from one of the exanthemata.

The *symptoms* are pain, loss of function in the joint, a high temperature, and a sudden onset. The actual nature of the illness may be overlooked until the formation of an abscess enables the surgeon, after opening it, to demonstrate the presence of dead or carious bone.

The *treatment* consists in cutting down upon the inflamed bone as soon as possible, when, if pus has already found its way into the joint, there need be no hesitation in thoroughly draining its cavity, for even prolonged drainage is not inconsistent with a useful joint afterwards.

Acute arthritis in children is considered under the heading syphilitic disease of the shoulder.

Tuberculous Disease. — *Pathology.* — The shoulder is affected with tubercle in about 25 per cent of tuberculous joints. As is usual in joints, the cancellous bone of the head and the synovial membrane are affected, the stress of the inflammation seeming sometimes to fall more upon the one than upon the other, and without adequate reason. When suppuration occurs the abscess usually tracks along the tendon of the biceps or opens into the bursa beneath the deltoid. More rarely it appears in the axilla, or it may point behind in the supraspinatus or infraspinatus fossæ. Enlarged bursæ and prolongations from the synovial membrane sometimes appear at a distance from the joint, with which they may have no obvious connection. Such enlargements are known as Baker's cysts, and are always indicative of tuberculous disease of the joint. The head of the femur in advanced cases may be reduced to a mere shell of bone, or it may die and lie loose as a sequestrum within the capsule. There is also an interesting group of cases in which tuberculous inflammation of the shoulder may run its entire course to anchylosis without sufficient symptoms to draw attention to the joint, so that a completely fixed shoulder may be found in a child who hardly seems to have been ill.

Symptoms.—The most prominent symptoms are wasting of the deltoid and scapular muscles, with internal rotation and adduction of the arm. The joint is stiff, and the inferior angle of the scapula moves coincidently with the humerus when the arm is rotated, when the elbow is moved backwards or forwards, or when it is drawn away from the side. Pain is not usually a marked feature in the disease, but if it occurs it is referred to the middle of the arm near the insertion of the deltoid.

Prognosis.—The prognosis is better than in tuberculous disease of other joints.

Treatment.—The joint should be put at rest by applying a plaster-of-Paris bandage after a pad dusted with oxide of zinc powder has been placed in the axilla to produce a certain amount

of abduction. In the rare cases when the pain is severe the actual cautery or the application of a succession of small blisters is often useful. The joint should be kept at rest for a period of from three to six months. The free movement of the scapula upon the trunk makes it almost useless to attempt passive movements between the scapula and humerus; for if the shoulder is going to anchylose it will do so in spite of all the surgeon's efforts, whilst he cannot take any credit for a movable joint. An abscess should be opened as soon as it is noticed, and an atypical excision is sometimes required when persistent sinuses make it probable that there is carious or necrosing bone. Formal excisions of the head of the bone are becoming less and less frequent.

Syphilis.—Surgeons are so accustomed to treat cases of tuberculous inflammation in joints that they are apt to overlook the various arthritic manifestations of syphilis. Several forms of syphilitic inflammation occur in the shoulder.

Acute Arthritis.—*Symptoms.*—The earliest syphilitic manifestation occurs in connection with the epiphyseal line, leading in some cases to early synostosis, and thus to the stunting of the bone, which is sometimes extraordinarily shortened. More usually, however, the joint becomes inflamed. Within a few months of birth the child is noticed to move one arm less than the other, and to cry when its shoulder is touched. The skin is normal at first, but it soon becomes congested and bluish in colour, the outline of the joint alters, and in a few days a globular swelling beneath the deltoid shows that an abscess has been formed. This condition may be mistaken for a malignant growth of the head of the humerus, but there is often other evidence of syphilis, whilst the rapidity with which a fluctuating swelling is formed, and the presence in it of pus, should be sufficient to prevent the surgeon from looking upon it as a sarcoma.

Treatment.—The abscess should be opened and drained as quickly as possible, and the inflammation soon subsides under the influence of grey powder, in doses of one-third to one grain three times a day.

Gummatous synovitis may occur in the shoulder, but it is less frequent in this joint than in the knee and ankle. It is liable to be mistaken for tuberculous synovitis, but it is less painful, and is rapidly cured when mercury is given.

Chondro-arthritis is the worst, as it is fortunately the rarest, syphilitic lesion in the shoulder. The head and shaft of the humerus are extensively affected by a rarefying osteitis, which is associated with a deposit of caseating material in the cancellous tissue. A similar process takes places in the articular cartilages, and leads to the formation of irregular grooves and pits in the head of the bone.

Symptoms.—The condition occurs about puberty, in consequence of inherited syphilis, and it may be preceded by transient attacks of synovitis, with evidence of chronic inflammation of the long bones. Many joints are simultaneously affected, and there is other evidence of syphilis, often with marked intraocular lesions.

Diagnosis.—The case is likely to be mistaken at first for tubercle, but it runs a slower course, and there is less tendency to suppuration.

Treatment is not of much avail. The internal administration of mercury and iodide of potassium seems to be useless, but some benefit may be derived perhaps from mercurial vapour baths and the inunction of a 10 per cent solution of oleate of mercury.

Arthritis Deformans, Osteo-Arthritis, or Rheumatoid Arthritis. — This chronic and troublesome affection attacks the shoulders in about a quarter of the total number of persons affected. The disease occurs in several different forms. In one variety the joint is uniformly enlarged, partly as a result of the thickening of the capsule, and partly in consequence of synovial effusion. Muscular atrophy is a pronounced feature, and there may be considerable muscular contracture. The amount of pain bears no relation to the severity of the articular lesion. It is sometimes hardly felt, whilst in other patients it is most distressing. In another variety, the stress of the disease falls upon the ends of the bones rather than upon the soft tissues of the joint. The joint is greatly deformed. It crackles and creaks on movement, and the motion may be hampered by the formation of osteophytes in the surrounding connective tissue. A third variety is limited to children, often in those who are found to have pericarditis. In these cases the lesion is chiefly synovial, and there appears to be no tendency to the formation of osteophytes. Yet it leads to anchylosis by the formation of bridges of bone after destruction of the articular cartilage.

Symptoms.—In a typical case the shoulder becomes troublesome about the age of 45 or 50. Pain is felt in and near the joint, and there is a persistent dull aching referred to the insertion of the deltoid. The symptoms slowly increase, and are soon accompanied by muscular wasting, and by a creaking or crackling sensation when the joint is moved. Changes take place both in the head of the humerus and in the glenoid cavity, until the appearances presented are those of an old subcoracoid dislocation. The long tendon of the biceps is occasionally destroyed, or it may be merely displaced from its groove. Suppuration occurs in a few instances.

The *pathology* of the condition is as yet unknown, but a body of evidence is slowly accumulating to show that some forms are perhaps very chronic infective inflammations, occurring in persons who are reduced by

overwork, mental worry, or unhealthy surroundings.

Treatment.—Prophylactic treatment will consist in ascertaining if there is any local cause of infection, even though it be but a slight cystitis, an inflamed tooth, or a pericardial affection. Palliative treatment consists in feeding the patient well, combined with massage of the affected muscles and the application of small blisters to relieve the pain. Hot air baths, by some apparatus of which Tallerman's is a type, may be employed advantageously in some forms of the disease. It is still too early to do more than allude to the curative effects of light, X-rays, and similar means which are at present being tried on an extensive scale at many different centres. There can be no doubt, however, that patients derive much benefit from the regimen prescribed at the baths of Bath, Buxton, Harrogate, and Strathpeffer at home, and at those at Aix-les-Bains, Nauheim, and Wildbad abroad.

Excision of the head of the humerus may be necessary in a few advanced cases of arthritis deformans, when the joint is very painful and crippled in a bad position, but I do not happen to have seen a case where it seemed advisable to perform such an operation.

Spinal Arthropathies.—The chief spinal arthropathies affecting the shoulder are syringomyelia and Charcot's disease, which is tabetic. In syringomyelia no less than 32 per cent of the cases exhibit lesions of the shoulder.

Pathology.—Syringomyelia is due to an alteration in the neuroglia of the spinal cord, which leads to the formation of one or more irregular cavities in the tissue. The disease usually begins in the upper part of the cord, the grey commissure and posterior cornua being first affected. Mr. Targett describes the joint as being affected in two forms. In the hypertrophic form the articular ends of the bones are deprived of their cartilage, and the exposed osseous tissue is worn away, but at the margins of these surfaces the cartilage is much thickened, and the ends of the bones are irregularly enlarged by osteophytes. The capsule of the joint is dilated and thickened by large deposits of bony and of calcareous material; its inner surface is beset with polypoid outgrowths of the synovial membrane. These pedunculated bodies may be very abundant, and occupy much of the cavity of the joint. There is often a coincident production of new bone upon the adjacent part of the shaft, either in the form of exostoses or as a general thickening of the diaphysis by an osteoplastic periostitis. The attachments of the tendons, ligaments, and fasciæ near the joint are liable to become ossified. In syringomyelia, as in tabes, the bones exhibit a predisposition to spontaneous fracture, and when such fractures are intracapsular the displacement of the fragments may cause great deformity of the joint. The atrophic variety of syringomyelia is distinguished by rarefaction of the cancellous tissue and very extensive destruction of the ends of the bones. Thus the glenoid cavity and the neck of the scapula are gradually removed, the head of the humerus is worn away, and the atrophied upper end of the shaft plays upon the stump of the coracoid process. In this manner the humerus may be reduced several inches in length. The affected bones are exceptionally smooth and light from wasting, yet the tendency to ossification in the neighbouring muscles may still exist.

Symptoms.—The first indication of the disease is often a sudden, rapid, and almost painless effusion into the cavity of the joint, but without redness or heat. Three-quarters of the patients are men. The swelling usually subsides at first under treatment, but the attacks recur, and the capsule becomes in time so much relaxed that the shoulder may be dislocated. These signs are associated with marked impairment of sensations of pain, heat, and cold, though the tactile sense, the muscular sense, and the special senses are unaltered. Muscular atrophy commencing in the small muscles of the hand may extend until it involves the shoulder and trunk. Trophic lesions of the skin, such as bullous eruptions, ulcers, and painless whitlows (Morvan's disease), are not uncommon, whilst the effects of disturbed nutrition upon the finger nails may be very marked. It is not at all unusual, therefore, for the shoulder to suppurate in cases of syringomyelia, as a result of septic absorption from the ulcers on the skin. The bones become carious and necrosed, and as the condition is unattended with pain, the patient is said in some cases to have picked out his own sequestra and incised his own "felons." No treatment appears to be of any service; but the surgeon should bear in mind that the anæsthesia from which the patient suffers, requires him to take every precaution against accidental injury, for ulcers once formed cannot be cured, and their presence hastens the end.

Tabetic arthropathy or Charcot's disease affects the shoulder much less often than the knee, and is at first hardly distinguishable from arthritis deformans. The articular surfaces of the shoulder joint are greatly altered. The glenoid cavity is replaced by a large hollow, bounded above and in front by the acromion and the coracoid processes, and below by a mass of bone springing from the axillary border of the scapula, and apparently produced by calcification of the long head of the triceps. The head of the humerus disappears, and the upper end of the bone may be converted into a large club-shaped mass, which is drawn upwards and forwards as in a subcoracoid dislocation. The joint may thus become flail-like, for the capsule is elongated. In other cases spontaneous frac-

ture of the humerus may take place in the neighbourhood of the joint.

Diagnosis.—There is usually no difficulty in making a diagnosis. The knee or hip is already affected, the knee-jerks are absent, and the characteristic ophthalmoscopic appearances are present. Charcot's disease may be distinguished from syringomyelia by the fact that it does not suppurate, and that there is no anæsthesia.

No treatment is curative, and it can only be directed to save the joint as far as possible.

Loose Bodies.—Loose cartilages are found less often in the shoulder than in the knee and elbow, but from the frequency with which the shoulder is the seat of tuberculous disease and of arthritis deformans enlarged synovial fringes are not uncommon. The loose bodies derived from the synovial fringes are of several kinds. They are sometimes numerous and vesicular, apparently derived from cystic degeneration of the synovial fringes; at other times they are multiple and cartilaginous, as is common in joints affected with arthritis deformans, the cartilage cells being developed by a proliferation of the cartilage cells which are found in healthy synovial fringes. Melon-seed bodies occur in the shoulder as a result of a chronic plastic synovitis. They consist of fibrin, and every stage can be traced from a rough mass of fibrin to the smooth and flattened masses which so closely resemble melon seeds in appearance.

Treatment.—A simple incision into the joint from in front will allow of the removal of the loose bodies, if they are troublesome; but it should be remembered that such joints are often on the verge of disease, and unless the wound heals by first intention a severe arthritis may be set up.

Paralytic Deformities of the Shoulder.—The deltoid and the serratus magnus are the muscles most likely to be paralysed in connection with the shoulder.

Paralysis of the deltoid is due to spinal paralysis or to injury of the circumflex nerve. The shoulder is much flattened, and appears angular, for the projecting acromion stands out in marked relief. The relaxation of the ligaments is also well marked, for the finger can be passed between the head of the humerus and the glenoid cavity when the arm is drawn slightly downwards.

Paralysis of the serratus magnus is an interesting affection, which may be bilateral, and is often associated with paresis of the rhomboids and trapezius.

Causes.—The condition may be congenital or acquired. In rare cases there may be a congenital absence of muscles, more commonly it is the result of cold. The last patient whom I saw was a boy of nineteen who had lately been apprenticed to his father, a butcher, and he had to cry his wares outside the shop in all weathers. In other cases it may follow typhoid fever, infantile or other paralysis, or may occur in progressive muscular atrophy.

Symptoms.—The patient complains of weakness in the shoulder, and his friends notice that he has "winged scapulæ," for the condition may be bilateral. The weakness is due to the fact that the inferior angle of the scapula slips forwards and stands out beneath the skin when the patient holds out his arm straight in front of his body. There is a diminution in the length and power of the reach of the affected arm, and the patient is unable to extend the arm upwards and forwards without bending the body sideways and flexing the forearm, the humerus being at the same time much abducted. This is due to the paralysed serratus failing to fix the scapula upon the ribs, by which means alone its rotation is possible. The surgeon can readily explore the under surface of the scapula with his fingers, so great is the separation between the bone and the thorax.

Diagnosis.—An examination of the spines of the vertebræ will distinguish this condition from the "scapula alata" of lateral curvature.

Treatment.—The affected shoulder should be galvanised two or three times a week with an induced current, strong at first and afterwards weaker. The positive pole should be placed over the spine on a level with the upper border of the scapula, whilst the negative pole is placed successively over the different digitations of the serratus magnus. Massage may also be usefully employed, the shoulder being kept warm and a sling being worn in the intervals of treatment. The patient should be put upon a course of strychnia and iron, and if there is much pain a blister may be applied over the lower part of the scalenus anticus muscle, *i.e.* over the clavicular insertion of the sterno-mastoid muscle, with the intention of causing some counter-irritation of the external respiratory nerve of Bell.

Tumours

The clavicle, the scapula, and the upper end of the humerus are all liable to tumour formation, the growths being either innocent or malignant.

The innocent tumours are either bony or cartilaginous. The bony tumours are of the nature of exostoses, and grow chiefly from the scapula though they spring sometimes from the neck of the humerus, causing pain and venous congestion of the arm if they project into the axilla. Cartilaginous tumours grow as pure chondromata from the scapula. They undergo the various forms of degeneration common to this kind of growth, viz. cystic degeneration, fatty change, myxomatous degeneration and calcification. The rapid softening of the tumour which takes place in connection with the cystic degeneration sometimes leads to

a chondroma being mistaken for a sarcoma. Myelomata, formerly called myeloid sarcomata, grow in connection with the clavicle, with the neck of the scapula, and with the upper end of the humerus always as tumours beginning inside the bone and leading to its expansion as they grow. The myelomata used to be looked upon as malignant growths, but the tendency of modern pathology is to place them amongst the innocent tumours, for they do not recur if they be removed whilst they are still encapsuled by bone. They often follow an injury to the shoulder, and in their early stages may be mistaken for sprains, or rheumatic affections resulting from the accident. They are allowed, therefore, to attain a considerable size, and have too often involved the soft tissues before a diagnosis is made. Clinically, therefore, they are malignant of the least malignant type. The increased size of the bone can be recognised by careful examination as well as by the radioscopic appearances, and the treatment will depend upon the stage which the growth has reached.

The treatment consists in removal of the tumour by excision of the affected bone, or by the more formidable amputation at the shoulder joint (*see* p. 156).

The malignant tumours of the shoulder are always subperiosteal sarcomata, so far as they come under the observation of the surgeon, though the pathologist occasionally finds secondary deposits of cancer in the head of the humerus in patients who have died of scirrhus of the breast, and as a pathological curiosity cancer of the upper end of the humerus may be secondary to a uterine carcinoma.

The sarcomata are spindle-celled, chondrifying, ossifying, or mingled with fibrous or myxomatous tissue. The early symptoms, especially when the growth is at the upper end of the humerus, are very obscure, and may consist of little more than impaired movement at the shoulder. In the later stages the rapid growth, the enlarged joint with congested veins and inflamed skin, may lead the surgeon to think he is dealing with some inflammatory condition, especially as the patient may appear to be in good general health, and there is an absence of the ulceration and cachexia which are too often thought to be always associated with malignant disease. Sarcoma of the scapula usually begins on the dorsum or at the neck of the bone, and the growth soon involves both surfaces, so that it is difficult to ascertain whether it began as a periosteal or as an endosteal tumour. The surrounding muscles are therefore quickly involved, and the disease runs a rapid course. The axillary glands are not often affected, but secondary tumours are found in the lungs, in the liver, and in the kidneys. The scapula may be excised, if the patient be seen early in the course of the disease, but recurrence is so frequent that it is better to perform Berger's operation of complete removal of the upper extremity (*see* p. 156).

Sarcoma of the clavicle is rare. It affects the neighbouring lymphatic glands, and recurs rapidly after removal. The growth is usually diagnosed at an earlier period than the other sarcomata of the shoulder, but it should not be mistaken for the more common tuberculous periostitis with osteitis of the bone. Complete resection of the clavicle may be undertaken (*see* p. 157).

Sarcoma of the humerus is especially malignant, for the tumour may spread along the whole length of the bone within a few weeks of its first appearance. It is more rare in the humerus, however, than in the tibia and femur. The surrounding muscles are quickly involved, but the axillary glands escape. Extension from the humerus to the clavicle and scapula are not at all uncommon, and it is advisable, therefore, in many cases to perform Berger's major operation upon the unfortunate patient.

Treatment.—The broad principle of treatment to be followed in malignant disease of the shoulder is early and complete removal of the growth as soon as the nature of the swelling is recognised. But to be of any service the operation must be performed before the growth has ulcerated, and, in the case of endosteal sarcomata, before spontaneous fracture announces that the growth has escaped from the bone and is involving the soft tissues. Amputation of the shoulder with or without excision of the scapula and removal of the outer portion of the clavicle is alone of service in most cases of malignant disease of the shoulder, and the more extensive the operation the more satisfactory will be the result, for there will be the less likelihood of recurrence.

Wounds of the Axillary Artery

Wounds of the axillary artery result from stabs and less commonly from injuries inflicted during the reduction of old-standing dislocations of the shoulder. The hæmorrhage varies with the extent of the wound. It may be so slight as to allow of repair and the subsequent formation of an axillary aneurysm, or it may lead to rapid death. The loss of blood externally is not necessarily very great, for the tissues of the armpit allow of great distension, and the bleeding may be in great part concealed.

Treatment.—Pressure upon the subclavian artery as it passes over the first rib will arrest the bleeding for a time, but local pressure is exercised with extreme difficulty at this spot. The axilla must be laid open as soon as possible, and a ligature must be tied round the artery at a point above and below the injury, the artery being afterwards divided between the two ligatures. No pads or compresses applied

to the axilla are of the least service in arresting hæmorrhage from the axillary artery.

Axillary Aneurysm.—An axillary aneurysm is nearly always the result of an injury to the artery, either in the form of an incomplete wound involving the outer and a portion of the middle coats, a small puncture, or more often a bruise or strain from the front of the shoulder. The loose cellular tissue in which the artery lies allows the aneurysm to attain a considerable size before it is discovered. The whole length of the artery may be involved, but in the cases which have come under my observation the aneurysm has been chiefly in the first and second parts of its course.

Treatment.—The treatment is most unsatisfactory. Ligature of the third part of the subclavian may be carried out when the aneurysm is seen early, but after it has attained a large size the shoulder is pressed upwards so much as to make this operation one of extreme difficulty. There is a great tendency too for the aneurysm to become diffuse. In such cases the condensed tissue covering the aneurysm may be exposed, and fine iron wire may be introduced through a cannula into the cavity of the tumour, the small aperture being afterwards closed by a suture of fine silk. In other cases it might be advisable to inject some sterilised gelatine into the cavity of the aneurysm. When the aneurysm leaks or shows other indications of rupture, amputation must be performed to save the life of the patient.

Operations

Abscesses.—The line of safety in opening an axillary abscess has already been pointed out (p. 144). It lies from the centre of the axilla, but not too near the apex, along the inner and thoracic wall of the space. Axillary abscesses are best opened by "Hilton's method." The skin is shaved, washed, and rendered as aseptic as possible. It is then incised until the axillary fascia is reached. This fascia is picked up with a pair of dissecting forceps, and is carefully divided until a pair of dressing forceps can be introduced through it. The forceps are passed into the axilla closed, and they are pushed on until pus escapes. The blades are then separated to enlarge the opening in the axillary fascia. When the abscess has been chronic, the surgeon introduces his finger and gently breaks down any loculi to make the cavity as simple as possible. A counter-opening is made at the most dependent part, and effective drainage is provided.

Amputations.—The shoulder may be amputated by two methods. It may be either disarticulated at the joint or the whole extremity may be removed, including the scapula and a portion of the clavicle. Disarticulation at the shoulder joint is performed for severe injuries, for gangrene of the arm, for disorganisation of the joint from disease, for some axillary aneurysms, and for malignant disease springing from the lower part of the shaft of the humerus. There are many different ways of amputating at the shoulder, but *Spence's method* is undoubtedly the best if it can be done. The arm to be removed is held away from the side, and is rotated outwards. The surgeon begins his incision half an inch external to the coracoid process, and carries it straight downwards and to the bone until he reaches the lower border of the insertion of the pectoralis major. He then carries his knife circularly round the arm, cutting only skin deep on the inner side where the great vessels and nerves are lying, but going down to the bone at all other parts. The outer flap, chiefly consisting of the deltoid muscle, is easily raised from the bone, the joint is opened, and the surgeon seizes the head and upper end of the humerus in his left hand, whilst, with the knife in his right, he frees the bone along the inner side until he reaches the level of the circular incision. He then tells the assistant to grasp the vessels in the flap above the point of division, and the disarticulation is completed by cutting through the biceps, coraco-brachialis, and other tissues from without inwards, *i.e.* towards the axilla.

The interscapulo-thoracic operation, or removal of the entire upper extremity, is commonly known as *Berger's operation.* It gives excellent results, and does not appear to be so serious as might be imagined *a priori.* It is of especial service in cases of sarcoma involving the scapula or upper end of the humerus, but it has also been employed in cases of extensive osteitis. The operation consists of three distinct parts: first, excision of the middle third of the clavicle; secondly, the application of a double ligature to the subclavian artery and vein, each vessel being afterwards divided; thirdly, removal of the arm and scapula by an antero-posterior flap. The patient is placed on his back with the arm drawn a little way from the side. The surgeon stands on the outer side of the limb, and makes his first incision along the outer two-thirds of the clavicle. This part of the bone is rapidly cleared of its soft parts, and the middle third is excised subperiosteally. The subclavian artery and vein are exposed, and two ligatures are passed round each, the ligatures on each vessel being at least half an inch apart; for there is a tendency for the distal ligature to come off when the vessel is divided, unless ample margin is left for the retraction of the artery. The vessels are divided, and the ligatures are cut short. The patient is now turned on his sound side, while the limb to be amputated is drawn away from the thorax, and the surgeon enters his knife at the middle of the clavicular incision, and carries it outwards and downwards in the interspace between the pectoral and deltoid muscles as far as the

lower edge of the teres major, which forms the posterior boundary of the axilla. The incision is then carried across the axilla until it ends at the posterior inferior angle of the scapula. The posterior flap is made by carrying the knife from the end of the clavicular incision backwards over the acromion by the shortest route to join the first incision at the posterior inferior angle of the scapula. The two flaps are dissected up as quickly as possible, and the arm with the scapula is removed, the smaller vessels being secured as the operation proceeds.

Excision of the Scapula.—The patient is placed upon the sound side, and the surgeon stands directly behind him. He begins his incision over the acromion process, and extends it along the spine as far as the vertebral border. A second incision is then made along the vertebral border of the scapula, commencing at the upper angle, and ending at the inferior angle of the bone. The flaps are dissected up, care being taken not to include any diseased or doubtful tissue. The muscles along the upper and vertebral borders are then detached, and the vertebral border is lifted upwards and outwards to allow of division of the serratus magnus and subscapularis muscles. The acromion process is sawn off at its junction with the spine and drawn forwards, so that the upper aspect of the shoulder joint is exposed. The capsule of the shoulder is divided, and the scapula is removed by cutting through the remaining tissues. The hæmorrhage attending the operation is considerable, and precautions should be taken to arrest it as quickly as possible, even by a preliminary ligature of the subclavian artery.

Various modifications of the formal operation may be required, according to the conditions attending the individual case. The tumour may be so situated that the neck and glenoid cavity may safely be left untouched, or, on the other hand, it may be necessary to remove the head of the humerus and part of the clavicle.

Excision of the Clavicle.—The clavicle is excised on account of sarcoma and necrosis. The operation is easy, for the bone is exposed and divided with a Hey's saw, care being taken not to injure the large vessels and nerves which lie directly behind it.

Excision of the Head of the Humerus.—The head of the humerus is excised for various conditions, the result of inflammation or injury, in which the movements of the shoulder are limited and painful. Anchylosis, tuberculous disease, osteoarthritis, which is arthritis deformans, and some irreducible dislocations of the shoulder are the most frequent conditions leading to excision.

The anterior incision has now supplanted the older method of excision by a deltoid flap. The arm is rotated outwards, and is drawn somewhat away from the side, whilst the surgeon stands facing the patient and opposite the joint he is about to open. The knife is entered on a level with and half an inch external to the coracoid process, and a vertical incision is made three inches in length through the anterior fibres of the deltoid. Care is taken to avoid the cephalic vein, which lies in the intermuscular space between the deltoid and the pectoralis major. The fibres of the deltoid are retracted, and the bicipital groove is then exposed and laid open in its whole length. The long tendon of the biceps is drawn out of the groove, and is held aside with an aneurysm needle or blunt hook. The capsule of the joint is laid open freely, and the arm is then rotated inwards until the supraspinatus, infraspinatus, and teres minor muscles can be detached from their insertion into the great tuberosity by the help of a periosteal elevator. The arm is afterwards rotated outwards, care being taken to preserve the long head of the biceps, and the subscapularis in like manner is detached from the lesser tuberosity. A blunt director is passed under the bone, which is divided with a narrow-bladed saw, the line of section usually passing through the tuberosities. The head of the bone is then removed with a pair of lion-forceps, and any further disease is gouged away. The glenoid cavity must be carefully examined when the operation is performed for tuberculous disease, and as much as possible of the pulpy synovial membrane should be cut away, whilst the edges of any sinuses are scraped and pared. A posterior incision must be made for drainage in every case. The drainage tube is passed to the most dependent part of the wound, the circumflex nerve and artery being carefully avoided; and, if the incision is made very low, the situation of the musculo-spiral nerve must be remembered. The resected extremity of the humerus is pushed into the glenoid cavity, and the wound is closed in the usual manner. A thick pad is placed in the axilla to prevent the humerus being drawn inwards.

Passive movement should be begun at the end of the first week, the tube being removed on the third day. The passive movements are increased gradually as the wound heals, the muscles, especially the deltoid, being shampooed and treated electrically. The after-treatment is maintained for many weeks, but the more extended movements, such as abduction, should not be practised until several weeks after the humerus is sufficiently fixed in the glenoid cavity, as there is some fear lest the end of the humerus should pass under the coracoid process, where it may form a coracoid articulation instead of the ordinary glenoid joint. Rotatory movements must be begun as soon as they can be made without pain. Complete mobility of the joint is hindered by the thickening of the capsule, which in some cases is shrunken and in some parts is as resistant as cicatricial tissue,

as well as to the fibrous and fatty degeneration of the muscles.

Ligature of Arteries.—The third part of the subclavian and the third part of the axillary arteries are the only vessels which need ligature in their continuity near the shoulder.

The line of incision for ligature of the third part of the subclavian artery is parallel with the middle third of the clavicle and half an inch above it, the shoulder being depressed as much as possible to diminish the depth of the supraclavicular fossa. Care is taken not to wound the external jugular vein, an accident which is best avoided by pulling the skin downwards and making the first incision over the clavicle, for the vein passes through the cervical fascia just above the bone, so that it is not pulled down with the skin. The platysma and the deep fascia are next divided to the full extent of the skin incision. A plexus of large veins lies just behind the clavicle, which should be carefully drawn aside, and, if necessary, divided after ligature. The posterior belly of the digastric is usually seen at this stage and is drawn upwards, whilst deeper than this lies the third cord of the brachial plexus, which forms the best guide to the artery, for it lies immediately below the cord, crossing the first rib. When there is any difficulty in finding the artery, the outer border of the scalenus anticus is traced downwards to the scalene tubercle on the first rib, and the artery lies immediately above and behind this tubercle. The aneurysm needle is passed from above downwards, as the lower cord of the brachial plexus is more likely to be included in the ligature than the subclavian vein, which lies below the artery and well away from it. The sheath of the artery must be opened and gently separated before the needle is passed, to diminish the risk of including the nerve to the subclavius muscle, which usually gives a filament to the phrenic.

The third part of the axillary artery is ligatured in its continuity through an incision three inches in length carried along the junction of the outer with the middle third of the axilla when the arm is fully extended and drawn away from the side, being at the same time rotated outwards. The inner border of the coraco-brachialis muscle is thus thrown into relief, and forms the guide to the artery. The inner border of the coraco-brachialis is defined, and is raised by a blunt hook, when the axillary vein and the median nerve immediately come into view. The artery lies between these two structures, and the needle should be passed away from the vein.

"Show."—The blood-stained mucus which comes from the cervix uteri and vaginal canal in the first stage of labour; it is due to active dilatation of the cervical canal, and indicates the commencement of parturition. *See* Labour, Stages and Duration (*First Stage, Phenomena*).

Shrapnell's Membrane. *See* Schrapnell's Membrane.

Shuttle Bone.—The scaphoid of the carpus; os naviculare.

S.I. — The initials S.I. stand, in Public Health, for *Sanitary Inspector*, an official acting either under the special directions of the Sanitary Authority (S.A.) or of the Medical Officer of Health (M.O.H.), or alone on his own initiative when performing the duties of an Inspector of Nuisances (I.N.). It is now generally required that he hold some certificate of which the Local Government Board (L.G.B.) approves; he shall report all nuisances to the Sanitary Authority (noxious trades, and breaches of the laws regulating the same), shall visit shops supplying food-stuffs and stop the sale of such as are unfit for use as food; he shall give notice of the occurrence of infectious diseases, and he shall take measures to prevent the spread of the same, etc.

Sialo-.—In compound words *sialo-* (Gr. σίαλον, spittle or foam) means relating to saliva; e.g. *sialodochium* (a salivary duct), *sialodochitis* (inflammation of the ducts of a salivary gland), *sialostenosis* (occlusion of a salivary duct), and *sialosyrinx* (a salivary fistula).

Sialogogues.—Medicines producing a flow of saliva or increasing the secretion of the salivary glands; this they do either by acting on the cells of the glands or the terminations of nerves in them (*e.g.* in the case of jaborandi, the iodine compounds, or mercury), or by acting reflexly and stimulating the peripheral ends of afferent nerves (*e.g.* in the case of acids, alcohol, mustard, and most emetics). *See* Pharmacology.

Sialolith. — A salivary calculus. *See* Salivary Glands, Disorders of (*Inflammations*).

Sibbens. *See* Venereal Disease (*Allied Diseases*).

Sibilant.—Making a hissing sound (Lat. *sibilare*, to hiss), *e.g.* a sibilant râle.

Sibson's Groove.—The furrow on the chest wall formed by the projection of the lower border of the pectoralis major muscle.

Sicchasia.—A morbid loathing of food (Gr. σικχός, a squeamish person.

Sicily. *See* Balneology (*Italy, Acireale and Sciacca*); Therapeutics, Health Resorts (*Italian*).

Sick Headache.—Headache accompanied by nausea. *See* INDIGESTION (*Hemicrania*); MIGRAINE and *Cross References.*

Sickness. — Nausea and vomiting, *e.g.* the morning sickness of pregnancy, or that following the administration of an anæsthetic; or a disease, *e.g.* sleeping sickness, falling sickness, green sickness, mountain sickness, etc.

Sickroom. *See* DISINFECTION.

Side-Chain Theory. *See* IMMUNITY, RECENT VIEWS (*Ehrlich's Theory*).

Sideration.—Apoplexy or erysipelas of the face and head, both of which were supposed by the ancients to be due to stellar influence (Lat. *sidus*, a star).

Sidero-.—In compound words *sidero-* (Gr. σίδηρος, iron) means relating to iron; e.g. *sideroscope* (an instrument for detecting grains of iron in the eyes), *sidero-dromophobia* (morbid fear of a railway journey), *siderophilous* (having the tendency to take up particles of iron; as exhibited by some blood corpuscles), etc.

Siderosis.—The morbid state of the lungs due to the inhalation of metal dust. *See* LUNGS, PNEUMONOKONIOSIS.

Sidmouth. *See* THERAPEUTICS, HEALTH RESORTS (*English*).

Sidonal.—Quinate of piperazin; recommended in gout and the uric acid diathesis.

Siegle's Speculum. *See* EAR, EXAMINATION OF (*Tympanic Membrane, Pneumatic Speculum*).

Sigaultian Operation. — Symphysiotomy. *See* LABOUR, OBSTETRIC OPERATIONS (*Symphysiotomy*).

Sighing. *See* BRAIN, AFFECTIONS OF BLOOD-VESSELS (*Anæmia of Brain, Symptoms*); CHILDREN, CLINICAL EXAMINATION OF (*Respiratory System, Breathing*); HEART, MYOCARDIUM AND ENDOCARDIUM (*Symptomatology, Dyspnœa*); STOMACH AND DUODENUM, DISEASES OF (*General Symptomatology, Remote Symptoms*).

Sight. *See* REFRACTION; VISION, FIELD OF; and *Cross References* under EYE.

Sigmatism.—Defective articulation, or too frequent use of the *s* sound in speaking.

Sigmoid.—Having the shape of the Greek letter (capital) Σ (sigma); *e.g.* the sigmoid flexure of the intestine, the sigmoid cavity of the ulna, and the sigmoid notch of the lower jaw.

Sigmoido-.—In compound words *sigmoido-* (Gr. σίγμα, s, and εἶδος, resemblance) means relating to the sigmoid flexure; e.g. *sigmoidopexy* (fixation of the sigmoid flexure in cases of prolapse), and *sigmoidostomy* (the making of an artificial anus in the sigmoid flexure). *See* INTESTINES, SURGICAL AFFECTIONS OF.

Sign.—An indication or mark of a disease; it is sometimes distinguished from a symptom, which is then regarded as an indication of disease observed by the patient alone, while the sign can be detected by the senses of the physician; phenomenon is sometimes used as a synonymous expression, *e.g.* the Argyll-Robertson phenomenon or sign in locomotor ataxia; a characteristic grouping of signs and symptoms is called a syndrome, or symptom-complex.

Signature.—In prescription-writing the name *signature* or *signetur* (*Sig.*) is given to the directions showing how and in what quantity the medicine is to be taken; it is often written in English. *See* PRESCRIBING (*Prescription Writing, Contractions*).

Silicosis. — The presence of siliceous particles (Lat. *silex*, flint) in the lungs or in some other organ, giving rise to fibrous changes; chalicosis. *See* LIVER, DISEASES OF (*Anthracosis and Silicosis*); LUNGS, PNEUMONOKONIOSIS (*Chalicosis*).

Silk and Silkworm Gut. *See* ASEPTIC TREATMENT OF WOUNDS (*Disinfection of Ligatures and Sutures*).

Sillyhow.—A popular name for the caul. *See* CAUL.

Silver. *See also* DRUG ERUPTIONS (*Argenti Nitras*); PHARMACOLOGY; TOXICOLOGY (*Irritants, Silver*).—Argentum. Symbol, Ag. Atomic weight, 107·11. The metal itself is not official, but is used as silver leaf for coating pills. The following are its official salts: — 1. ARGENTI NITRAS, known as lunar caustic. It is obtained in crystalline form by the interaction of the native sulphide and nitric acid, and is then melted into rods. It should be kept in the dark, as light blackens it. It is soluble 2 in 1 of water. *Dose*—$\frac{1}{4}$-$\frac{1}{2}$ gr. in pill with kaolin. *Preparations*—(1) *Argenti Nitras Induratus.* Consists of 19 parts of silver nitrate and 1 of potassium nitrate fused together. (2) *Argenti Nitras Mitigatus.* Consists of 1 part of silver nitrate and 2 of potassium nitrate fused together. 2. ARGENTI OXIDUM. Prepared by shaking together a solution of silver nitrate and lime-water. It is a brown powder, freely soluble in water. *Dose*—$\frac{1}{2}$-2 grs. in pill with kaolin.

Silver nitrate acts locally as a caustic, astringent, antiseptic, and hæmostatic. It forms a very firm coagulum with albumen, and precipitates chlorides. Its action is therefore purely local, and does not penetrate into the tissues. Lunar caustic is used for the destruction of

warts and exuberant granulations, and also as an application to bites. Continued bleeding from a leech-bite can be checked by touching with silver nitrate. It is recommended in erysipelas, a strong solution (about 160 grains to the ounce) being painted on the skin a little in advance of the spreading margin. Solutions of from 5 to 10 grains to the ounce are used with benefit in weak ulcers, in bed-sores, in pharyngitis, in laryngitis, and as an injection in gonorrhœa, gleet, and endocervicitis. Weaker solutions have been employed for injection into the bladder in cases of cystitis. Solutions of about 4 grains to the ounce may be employed in the treatment of conjunctivitis, and in obstinate cases the conjunctiva may be painted with stronger solutions. Many physicians make a practice of putting a drop of a 2 per cent solution into the eyes at birth so as to avoid the risks of purulent ophthalmia. Large quantities of a strength not greater than 1 grain to the ounce may be of service as a rectal injection in dysentery and obstinate diarrhœa. Silver salts are not much used internally, and their continuous administration is to be avoided on account of the discoloration of the skin produced. Argyria may also result from long-continued external application, as to an ulcerating surface. In some cases of hæmorrhage from the stomach silver nitrate acts well, especially if the patient is well under the influence of opium. In cases of severe diarrhœa its administration may be markedly beneficial. Its empirical use in chronic nervous diseases, such as chorea, epilepsy, and locomotor ataxia has now been entirely abandoned. The acetate, citrate, cyanide, iodide, lactate, and other salts of silver have all been used and recommended for special purposes in preference to the nitrate, but there does not appear to be any striking advantage attached to the use of any of them. *Argyrol*, a combination of silver with a proteid obtained from wheat, is said to be less irritating than the official salts, and has been used for the eye, and in treatment of diseases of the genito-urinary tract, with excellent results. It is freely soluble, and should be used in somewhat stronger solutions than the nitrate. *Protargol*, another proteid compound, has also been widely employed, especially in the treatment of gonorrhœa. *Collargol*, or colloid silver, has also been recommended strongly as an antiseptic in preference to the nitrate.

Silvester's Method.—A method of artificial respiration, the asphyxiated person being in the dorsal posture and having the tongue drawn forward; alternate compression and expansion of the chest is produced by movements of the arms. *See* Asphyxia (*Methods of Artificial Respiration*).

Simon's Operation.—An operation for complete rupture of the perineum.

Simon's Position.—The exaggerated lithotomy position.

Simon's Speculum. *See* Curettage (*Technique*).

Simon's Symptom.—The condition of immobility (or retraction) of the umbilicus; it is sometimes present in tubercular meningitis (*q.v.*).

Simonart's Bands.—Amniotic adhesions and bands attached at one end to the fœtus *in utero* and at the other to the amnion. *See* Pregnancy, Diseases and Death of the Fœtus (*Congenital Amputations*).

Simpson's Forceps.—The long forceps of Sir James Y. Simpson; also the axis-traction forceps of Sir Alex. R. Simpson, which is an application of the Tarnier principle of axis traction to Sir James Y. Simpson's long forceps. *See* Labour, Obstetric Operations (*Forceps*).

Simpson's Version.—A method of turning the infant *in utero*, both hands being used in the process, the internal one being passed deeply into the uterus and doing the greater part of the version. *See* Labour, Obstetric Operations (*Version*).

Sims' Position.—The semiprone posture used in gynæcological examinations and operations, especially for the introduction of the Sims' speculum. *See* Gynæcology, Diagnosis in (*Vaginal Specula, Spatular Variety*).

Simulation. *See* Malingering.

Sinalbin. *See* Mustard.

Sinapis Albæ Semina. *See* Mustard.

Sinapis Nigræ Semina. *See* Mustard.

Sinciput.—The anterior and upper part of the head, or the calvarium, as distinguished from the occiput. *See* Labour, Physiology of (*Passenger*).

Singer's Nodules. *See* Larynx, Acute and Chronic Inflammation (*Nodular Laryngitis*); Larynx, Benign Growths of (*Singer's Nodule*).

Singing. *See* Physiology, Respiration (*Voice, Singing*).

Singultus.—Hiccough (Lat. *singultare*, to sob). *See* Spasm (*Varieties, Diaphragmatic*).

Sinigrin.—Potassium myronate. *See* Mustard.

Sinistral.—On the left side; *sinistrad* means towards the left side.

Sinistro-.—In compound words *sinistro-* (Lat. *sinister*, left) means towards the left side or left; e.g. *sinistrocerebral* (relating to the left cerebral hemisphere), *sinistrotorsion* (twisting towards the left), etc.

Sinking. *See* Stomach and Duodenum, Diseases of (*General Symptomatology, Local Sensory Affections*).

Sinks. *See* Sewage and Drainage (*Lavatories, Baths, and Sinks*).

Sinus.—A cavity in a bone (*e.g.* an *air sinus*) or other tissue, a recess (*nasal sinus*), a space containing blood (*placental sinus* or *venous sinus*), or a fistula or tract which does not close up by healing. *See* Bone, Diseases of (*Results of Acute Suppurative Osteomyelitis*); Brain, Physiology of (*Venous Circulation*); Brain, Affections of Blood-Vessels (*Thrombosis in Cerebral Sinuses*); Brain, Surgery of (*Cerebral Abscess, Diagnosis*); Ear, Middle Chronic Suppuration (*Thrombosis of Lateral Sinus*); Mammary Gland, Diseases of (*Suppurative Mastitis, Persistent Sinuses*); Nose, Accessory Sinuses of (*Inflammation*); Urachus (*Development, Sinus Urogenitalis*); X-Rays (*Treatment of Sinuses*).

Sinusoidal Current.—An electrical current in which there is a regular periodicity of the curve, representing the rise and fall of electromotive force. *See* Electricity.

Sirenomelus.—A teratological type in which the lower limbs are rotated inwards and more or less completely fused into one; the pelvis is deformed, and the organs which usually occupy the pelvic cavity are wanting or rudimentary. *See* Teratology.

Siriasis. *See* Sunstroke (*Synonyms*).

Sismotherapy or Seismotherapy.—Vibration treatment (Gr. σεισμός, a shaking); a form of massage.

Site.—A place, position, or situation; *e.g.* the *placental site* (the part of the uterine wall to which the placenta is attached, the placental surface which is so attached being named the *placental area*), a *building site* (the portion of ground upon which it is intended to erect a building, and which must possess certain qualifications to make it suitable from a hygenic point of view).

Sito-.—In compound words *sito-* (Gr. σῖτος, wheat or food) means relating to food; e.g. *sitogen* (a food product) and *sitotoxin* (a poison produced in vegetable food-stuffs by the action of bacteria or fungi).

Sitology.—Dietetics. *See* Diet; Food; Invalid Feeding; etc.

Sitomania. — A morbid craving for food; bulimia.

Sitophobia.—A morbid aversion to food, or anorexia.

Situs Mutatus.—The displacement of an organ or group of organs; ectopia.

Situs Viscerum Inversus. — A peculiar displacement of the organs, in which those normally on the left side of the body are found on the right, and *vice versa*, the appearances produced being those seen in a mirror image; this teratological state is also known as heterotaxy, transposition of the viscera, and inversion of the viscera. The transposition is usually very complete, down to the minutest details in which the one side of the body differs from the other, *e.g.* the level of the testicles in the scrotum. *See* Teratology (*Heterotaxy*).

Sitz-bath. — A hip-bath. *See* Balneology (*Varieties of Bath*).

Sixth Nerve.—The sixth cranial nerve, or *abducens*. *See* Brain, Physiology (*Cranial Nerves*); Brain, Tumours of (*Localising Symptoms, Sixth Nerve*); Ocular Muscles, Affections of (*Etiology*); Physiology, Neuro-Muscular Mechanism (*Medulla*); Syphilis (*Tertiary, Internal Squint*).

Size-making. — An offensive trade, dealt with by the Public Health Act (England and Wales) of 1875; and by the Public Health (London) Act of 1891.

Skatol. — A decomposition product of albumen and proteids in the alimentary canal, having the formula C_9H_9N. *See* Fæces (*Chemical Examination*); Physiology, Food and Digestion (*Bacterial Action in the Alimentary Canal*).

Skatoxyl. — An oxidation product of skatol, found in the urine in cases of disease of the large intestine, and having the formula C_9H_9NO. *See* Urine, Pathological Changes in (*Aromatic Substances*).

Skeleton. *See* Bone; Fractures; Knee-Joint; Spine; etc.

Skeleton, Living. — An individual affected by such a degree of atrophy of the subcutaneous tissue as to reduce him to little more than skin and bone; the anomaly may be congenital.

Skene's Glands.—Properly speaking, Skene's *glands* are two small glands just inside the orifice of the urethra, while Skene's *tubes* or *tubules* are relics of the Wolffian ducts found in the ligamenta lata of the uterus or (occasionally) lower down in the neighbourhood of the cervix uteri and urethra. *See* Generation,

Female Organs of (*Vestibule, Meatus Urinarius*); Urethra, Diseases of (*Anatomy*).

Skiagraphy. — The production of pictures of internal parts by the X-rays, the pictures themselves being termed *skiagrams*; radiography. *See* X-Rays; Joints, Diseases of (*Ankylosis, Diagnosis*); Larynx, Examination of (*Skiagraphy*).

Skiatherapy.—The treatment of disease by the X-rays. *See* X-Rays.

Skin.

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General Introduction. — The human skin, considered embryologically, may be said to consist of only two layers, namely, the epidermis and the corium, developed respectively from the epiblastic and mesoblastic layers of the blastodermic vesicle. The subcutaneous tissue, on account of the great difference in appearance which exists between it and the corium, was at one time believed to belong to a different category and to have developed from a different layer, but most observers are now agreed that, like the corium, it is of mesoblastic origin, and that it should be regarded simply as a deeper layer of the corium, in which some of the cells have become specialised by the deposition within them of fat. The epidermis and its appendages —the hairs, skin-glands, and nails—are in this way clearly differentiated from the fibrous

corium which underlies and supports them, by their origin as well as by the minute structure of their elements.

The Superficial Architecture of the Skin.—The surface of the skin is everywhere traversed by ridges and furrows which vary in different situations in regularity, arrangement, and size, and which to a considerable extent determine the shape of many of the elementary lesions of the skin, such as macules and papules. The existence of these ridges is dependent on three factors: (1) the arrangement of the fibrous bundles and elastic fibres of the underlying corium; (2) the direction of the movements to which the parts are subjected; and (3) the attachment of the skin by fibrous bundles to deeper structures, such as the capsules of joints.

There are two distinct varieties of furrows on the surface of the skin: (*a*) *Fine furrows*, which tend to run parallel to one another, and are best marked on the flexor aspects of the tips of the fingers and toes, where they form more or less regular patterns which differ in each individual; and, (*b*) *Coarse or deep furrows*, which are most pronounced in the neighbourhood of the joints, and are due to the fixing down of the skin by fibrous bundles to underlying structures, such as the periosteum of bone and the joint-capsules. In old age, and as the result of wasting diseases, wrinkles or *folds of emaciation* occur, from the removal of the tension caused by the disappearance of the subcutaneous fat.

The Epidermis.—For purposes of description the epidermis is divided into five distinct layers, named from within outwards: the stratum germinativum, the stratum Malpighii, the stratum granulosum, the stratum lucidum, and the stratum corneum. This division, though useful, is arbitrary, and these layers are ill-defined; they indicate the stages in the evolution of the epidermal cell from its simplest type in the stratum germinativum, till it becomes a perfect horn-cell. The epidermis as a whole is thickest on the palms and soles, and thinnest on the elbows, forehead, and cheeks.

(*a*) *Stratum Germinativum.*—This constitutes the basal layer of the epidermis, and usually consists of a single row of columnar cells with oval nuclei. These cells are arranged at right angles to the imaginary wavy line which separates the epidermis from the corium. They are constantly dividing by mitosis, and their whole function is that of reproduction; they have been named the "mother-cells" of the epidermis. Between them and above them smaller "daughter-cells" may here and there be detected; these latter do not as a rule exhibit mitotic figures, and their function is that of differentiation; they are simply pushed towards the surface of the skin by the addition of new layers of cells beneath them, and in their passage they are gradually differentiated till they become horny squames. The cells of the basal layer are united by fine protoplasmic threads or fibres, which towards the corium are collected into tufts, giving the line of demarcation a denticulated appearance.

(*b*) *Stratum Malpighii.*—This layer consists of a varying number of rows of polygonal cells, built up in the form of a mosaic; these cells tend to become flattened towards the surface of the skin. They possess large, round or oval nuclei, and are united by delicate protoplasmic fibres continuous with the spongioplastic network of the cells. In this way the cells of this layer are in organic connection with the other. Owing to the presence of the intercellular protoplasmic fibres the cells of this layer were named "prickle-cells" by Max Schultze. In spite of the delicate appearance of the protoplasmic fibres the latter are relatively resistant structures, and are unaffected by boiling water, and weak acids only cause them to swell. Between the cells lymphatic spaces occur which are bridged over by the prickles, and in which the fibres of the interepithelial nerve plexus are distributed. Peculiar spiral fibres situated between the prickle-cells and the cells of the basal layer have been described by Herxheimer. These are generally believed to be either threads of fibrin or protoplasmic fibres passing between cells of different layers.

(*c*) *Stratum Granulosum.*—Towards the surface the prickle-cell layer merges into a layer consisting of two or three rows of flattened granular cells with shrivelled nuclei lying in spaces, and shrunken protoplasmic fibrils.

The granules are most numerous in the cell-protoplasm near the nuclear space. They vary in shape and size from small roundish specks to course irregular lumps, and are strongly light-refractive. They consist of a semi-solid substance known as *keratohyalin*, which is insoluble in alcohol, ether, chloroform, and weak acids, is digestible in pepsin and hydrochloric acid, and is not stained by osmic acid.

Its origin is still *sub judice*, but it is most probably a separation product of the protoplasm of the cell.

(*d*) *Stratum Lucidum.*—This layer has been so called because in unstained sections it may be seen as the semi-transparent line resembling a narrow oily streak across a sheet of paper. It consists of one or more rows of somewhat swollen irregular cells, in which the nuclei are much shrunken and frequently replaced by a mass of débris. In these cells the keratohyalin has disappeared and been replaced by an oily substance named *eleidin*, which is present not only within, but also between the cells. This substance is slightly soluble in alcohol, insoluble in ether, digestible in pepsin and hydrochloric acid, soluble in acids and alkalies, and it does not stain with osmic acid. Fat

globules are also present in the cells. Like keratohyalin, the origin of eleidin is undecided, but it seems possible that it is a degenerative product of the former substance.

(*e*) *Stratum Corneum.*—The stratun corneum is the most superficial layer of skin, and is the layer which we see and touch. It is thickest on the soles and palms, and thinnest on the face. It is composed of horn-cells, which are most perfect next to the stratum lucidum, while towards the surface they become more and more flattened and dried till they form the squames.

A perfect horn-cell is polygonal in shape, is facetted from pressure, and presents a space in the centre of the cell from which the nucleus has disappeared. Eleidin can no longer be detected in it, but in place of it there is a fatty or waxy substance. The periphery of the cell has become hardened, and the prickles have persisted as dried up, hard spicules of a highly resistant substance known as *keratin.* The latter is indigestible in pepsin-hydrochloric acid, and can withstand 50 per cent solutions of mineral acids for a prolonged period. The most probable explanation of the formation of keratin is that it is the result of the hardening of the protoplasmic fibrils, and possibly of the outer portion of the spongioplasm, by an inherent power of their own, and that it is not a degenerative product resulting from the breaking down of the nuclei, nor a further stage of keratohyalin or eleidin, the latter substances being merely regarded as accessory to the process of cornification.

The presence of fat within the cells of this layer gives it the character of a waterproof coating, and the persistence of the protoplasmic fibres in the form of hard keratin spicules welding the cells together, readily explains the protective power which the stratum corneum is capable of exhibiting against the entrance of micro-organisms and their toxins, and its great ability to resist mechanical injuries.

Corium.—The corium is the dense fibrous layer of the skin, which gives to the latter its strength and elasticity. It supports and protects the hair-follicles, glands, nerves, and blood-vessels. Structurally it is built up chiefly of white fibrous tissue and a variable amount of yellow elastic tissue, and it presents certain well-recognised cellular elements.

It is customary to divide the corium into a superficial and a deep layer, known respectively as the *papillary* and *reticular layers.* In the former the white fibrous bundles are thin, loosely packed together, and tend to have a vertical direction, while in the latter they are coarse and form a dense complicated network, the meshes of which tend to be arranged horizontally.

The *papillæ* are conical projections of the corium into the overlying epidermis, in which are found the terminal capillary loops and certain nerve-endings; according as they support the former or the latter they are known as vascular or nerve papillæ. They are situated on ridges of varying height, arranged more or less parallel to each other. They may be single or more rarely compound, are longest on the flexor aspects of the finger-tips and toes, and are specially numerous about the areolæ of the nipples.

Minute Structure of the Corium.—1. *Cellular Elements.*—The cellular elements in the healthy corium consist of *fixed cells* and *migratory cells.* The latter are the different forms of leucocytes, and are specially noticeable near the blood-vessels, lymphatics, and in the papillary layer.

The *fixed cells* of the corium constitute the more important group. They are not all absolutely fixed to fibrous structures, as some of them are unattached and may be carried about in the lymph stream, but their movement is purely passive. There are three distinct types of *fixed cells* in the corium, namely—

(1) *Ordinary connective tissue cells,* which, as a rule, are spindle-shaped, but may be polygonal. They have usually long processes, tapering to fine threads, which in young connective tissue frequently unite with those of neighbouring cells to form a meshwork. The nuclei of the cells vary according to the shape of the cells, some being oval, others round, and a few may be polygonal. These nuclei are peculiar in having a coarse intranuclear network with unusually open meshes, producing a "vesicular" appearance.

Frequently only the nuclei of the cells can be detected, and even with the most careful staining no protoplasm can be recognised around them. As a rule the cells or nuclei are found flattened between the fibrous bundles of the corium, and at times their processes may surround bundles and line the lymphatic spaces between them like an endothelium.

(2) *Vacuolated Cells.*—These differ from the ordinary type of connective tissue cell in having no processes, and in that their protoplasm appears to be vacuolated, since the meshes of their spongioplasm are unusually large and rounded. Schæfer maintains that their cells possess distinct cavities containing a fluid like lymph. The nuclei of the cells are "vesicular" in character, and mytotic figures may occasionally be detected within them. It is just possible that these cells are the mother-cells of the corium, whose function is exclusively that of reproduction, and that they bear the same relation to the corium that the cells of the basal layer do to the epidermis.

(3) *Mast-Cells.*—This type of cell is distinguished by the presence in its protoplasm of numerous coarse granules which have a marked affinity for alkaline dyes. In shape and size they are as various as the ordinary connective

tissue cells. Their nuclei do not stain well, frequently present no nucleoli, and are generally more or less obscured by the granules. The latter vary in shape, some being round, others angular; as to size, they may be described as "coarse granules."

These cells occur chiefly in the neighbourhood of the blood-vessels, hair-follicles, and sebaceous glands, and are found in greatest number in the skin of pigmented regions, such as the scrotum and areolæ of the nipples.

The nature and origin of the mast-cell granules are still undecided. A possible explanation is, that they are a separation or degeneration product of the protoplasm of the cells, somewhat allied to mucin.

2. *Fibrous Elements of the Corium.*—(1) *The white fibrous bundles* are composed of numerous fibres about the breadth of a red blood corpuscle, united by a semi-fluid material. These fibres are made up of fine fibrils of a substance known as *collagen.* The fibres readily split into the component fibrils; the latter are incapable of branching. The bundles are flexible and slightly extensible, and, seen longitudinally, they present a wavy appearance which disappears when the skin is stretched.

Collagen is an albuminoid substance, and is probably the anhydride of gelatine.

There are two opposing views regarding the origin of the white fibrous bundles: one, that they are the result of a direct transformation of the protoplasm of the connective tissue cells, and the other, that they are formed by the deposition of fibres in an intercellular substance secreted by the cells.

(2) *The elastic fibres of the corium* are arranged parallel or obliquely to the collagenous bundles, and are most numerous in the reticular layer. They envelop the coil and ducts of the sweat-glands, and are present around the hair-follicles, sebaceous glands, and arrectores pilorum. The distribution of their fibres is so universal that they form a skeleton supporting the various elements of the corium. The elasticity of these fibres is not nearly so great as was at one time supposed, and it is considerably less than that possessed by the collagenous fibres.

Unlike the former, the elastic fibres are capable of branching and of uniting with neighbouring fibres to form a meshwork. In section they are angular in outline, and they tend to curl up on being broken across. They are composed of an albuminoid substance called *elastin*, which is more resistant to the action of weak acids and alkalies than collagen. The origin of the elastic fibres is undecided, and they have not been definitely proved to be capable of regeneration.

The Subcutaneous Tissue.—This structure may be regarded as the deepest layer of the corium, the cells of which have become infiltrated with fat. This layer serves three important purposes:—

(1) It forms a pad which protects the delicate underlying structures from being harmed by injuries to the skin.

(2) Being a bad conductor of heat, it prevents too great a loss of heat by radiation and evaporation.

(3) It forms a supporting framework for various delicate structures, such as the Pacinian bodies, nerve-trunks, coil-glands and blood-vessels.

It is especially thick on the palms and soles, and thin on the face. In structure it consists of a coarse fibrous meshwork enclosing large groups of fat-cells; these are known as *fat-lobes.* The fibrous walls separating the lobes are named "*trabeculæ.*" The lobes are broken up by fibrous *septa* into *lobules.* The lobes, lobules, and individual fat-cells are richly supplied with blood-vessels and lympathics, which are distributed in the trabeculæ and septa, and form a capillary meshwork between the cells. *Fat-columns* (*columnæ adiposæ*) have also been described, which pass vertically along the larger vessels from the fat-lobules to the coil-glands in the corium.

The individual *fat-cells* are large, oval, round, or polygonal bodies, consisting of a globule of fat encapsuled in a homogeneous mantle. The latter is the remains of the protoplasm of the cells, and at one side of it a flattened nucleus may generally be detected. These cells are the result of a fatty infiltration of connective tissue cells.

Other Situations in the Skin where Fat is found.—Small fat granules or globules occur in the epithelial cells of the sweat-apparatus, and in the lumen of the sweat-coil and duct. They are present also in the lymphatic spaces of the corium, in the walls of the vessels, and in the medullæ of nerves.

In the epithelium, fat occurs in the nuclear spaces of the prickle-cells, in the interepithelial lymphatics, and in the cells of the stratum corneum. It is also present in the epidermal cells of the hair-follicles.

The origin of the skin-fat has been a fruitful source of controversy. The leading theories on the subject are:—

1. That the skin-fat is a product of degeneration of the cell-protoplasm.

2. That it is a product of secretion of the cell-protoplasm.

3. That the subcutaneous fat, and that which occurs in the lymphatics of the skin, is derived from the coil-glands.

4. That the epithelial fat comes from the sebaceous glands.

It is generally conceded that the fat of the sebaceous glands and that which occurs in the stratum corneum is a separation or degeneration product of the protoplasm of the cell; but this

explanation does not apply to the subcutaneous fat, for in the latter situation the cells are not degenerated, and the fat is of the nature of an infiltration. The presence of fat in the coil-glands and ducts has been noted by a large number of observers, and Unna has strongly advocated the view that the subcutaneous fat is derived from that source. The lymph which bathes the coil is said by him to be loaded with fat. It is taken up, as a rule, by the small venules, and in the process is filtered and the fat deposited. The latter accumulates in columns around the blood-vessels, and is eventually taken up by the connective tissue cells of the subcutaneous tissue.

Epidermal Appendages. — 1. *Hairs.* — (*a*) *General Characteristics.*—Hairs are present on all parts of the human skin, except the palms, soles, red portions of the lips, ungual phalanges, and glans penis. There are three types of hairs, namely :—

(1) *Long hairs* such as occur on the scalp, beard, moustache, axillæ, and pubes.

(2) *Stiff hairs*, or *bristles*, such as the eyelashes (cilia), and the hairs of the nasal and auditory orifices (vibrissæ and tragi).

(3) *Lanugo*, or *downy hairs.*

The long hairs and the lanugo hairs are implanted more or less obliquely in the skin; the bristles vertically. The shape of the hair in section varies in different individuals and in different races. Straight hairs are, as a rule, circular, while curly hairs are generally oval; and on the beard, and occasionally on the scalp, angular figures may be produced. Hairs differ greatly in thickness, being thickest on the head and about the genitalia. The various colours of the hair are dependent on three factors :—

(1) Pigment granules situated in and around the cells of the hair-cortex.

(2) The diffuse colour of the protoplasm of the hair-cells.

(3) The presence of air between the hair-cells.

The diffuse colour of the protoplasm is said to produce blonde or reddish shades, while the granules are regarded as being responsible for black and brunette tints. The presence of air between the cells causes the hair to become grey or white.

During life the hairs have a limited existence, and are shed at varying intervals. In the scalp they have been said to have a life of from two to four years.

(*b*) *Structure of the Hair.*—The hair consists of a shaft or stem which widens out at the lower end to form a bulbous swelling known as the root. The root and part of the shaft are situated in the hair-follicle; the remainder of the hair is free.

(1) *Shaft.*—The greater portion of the shaft is formed by the hair-cortex, in the centre of which there is a more variable structure known as the medulla. The cortex is protected externally by a sheath or cuticle.

(*α*) The *cuticle* consists of a single layer of flat, quadrilateral cells arranged in an imbricated manner, with their long axes directed upwards and outwards at an acute angle to the shaft.

(*β*) The *cortex* is made up of bundles of nucleated spindle-shaped cells, which give it a fibrilated appearance. These spindles have ridges on the surface, and interlock to form a highly resistant structure. The cells contain a diffuse yellowish colouring matter and pigment granules; air may be detected between and occasionally within them.

(*γ*) The *medulla* occurs, as a rule, only in the hairs of the scalp, beard, axillæ, and pubes. It ceases towards the points of the hairs. It is composed of rouleaux of plates, consisting of three or four flattened cells, which, near the hair-root, contain keratohyalin granules.

(2) *Root or Bulb.*—The root is softer and lighter in colour than the shaft, but is composed of the same two or three layers of cells, but these are much less differentiated and more cubical in shape than in the shaft. It is indented beneath by the upgrowing vascular papilla of the hair.

(*c*) *Structure of Hair-follicle.*—The hair-follicle is a simple invagination of the epidermis enveloped by a condensed layer of connective tissue of the corium. It ensheathes and protects the growing portion of the hair.

It may be divided for descriptive purposes into an upper third or funnel, a middle third in connection with which are the sebaceous glands and arrectores pilorum, and a lower third which ensheathes the hair-root and which is indented below by the papilla. In the upper third the epidermal layers lining the follicle are the same as those of the epidermis, the continuation of the stratum corneum being next the hair, but in the lower two-thirds only the prickle-cell layer and the basal layer of the epidermis persist.

The continuation of the prickle-cell and basal layers is generally known as the "*external root-sheath*" of the follicle, and consists of several rows of polygonal prickle-cells with large round nuclei.

Between this layer and the hair there is a complicated structure named the "*internal root-sheath.*" It is only present in the lower two-thirds of the follicle; it begins at the papilla as several layers of polygonal nucleated cells containing granules of keratohyalin. As the cells ascend in the follicle, those next the external root-sheath become cornified, while in those next the hair the cornification process is much less rapid, and owing to the difference in the degree of cornification, the layer tends to split longitudinally in two, which are known respectively as the sheaths of Huxley and Henle.

Within the internal root-sheath there is a

cuticle formed of a single layer of elongated cells whose long axes being directed downwards and inwards make the cells to fit between the cells of the hair-cuticle. Hence it is almost impossible to epilate a hair without pulling out part of the root-sheath.

Enclosing the epidermal sheath of the follicle there is a dense fibrous layer derived from the corium, which is known as the "*connective tissue layer of the follicle.*" It is made up of collagenous and elastic fibres, which are externally arranged longitudinally, while nearer the hair they tend to have a circular direction. Next the epidermal layer they become so condensed and homogeneous that they form a layer which has been described as the "*hyalin or vitreous layer.*"

(*d*) *The Papilla.*—The papilla of the hair is a differentiated conical process of the corium analogous to a papilla of the papillary layer. It is composed of connective tissue fibres supporting a capillary loop and one or more medullated nerves. Through it the root is nourished, and any interference with its function through injury or disease causes a cessation of growth of the hair.

2. *The Sebaceous Glands.*—These are small saccular glands which occur usually in connection with the hair-follicles, but are also found, independent of these stuctures, in the skin of the borders of the lips and the areolæ of the nipples. They are generally placed on the oblique side of the hair-follicles, in the angle between the latter and the arrector pili. They vary considerably in size, from mere appendages to the hair-follicle to structures larger than the follicle itself.

They are largest about the nose, scrotum, and areola of the nipple; they may consist of a single saccule or of a bunch of twenty or more.

These saccules either open into a common duct, which pours its contents into the neck of the follicle to lubricate the hair, or, in the case of the independent glands, directly on the surface of the skin.

Histologically each saccule presents a connective tissue sheath, inside which there is a basement layer of flat cells surrounding a mosaic of large polygonal cells with round or oval nuclei. The latter cells have undergone a change; their protoplasm has been converted into fat-droplets, and their spongioplasm into a substance almost as resistant as keratin. The duct has the same minute structure as the saccule. The central cells of the saccules and duct break up, and the fat-droplets become discharged and collect in the lumen of the duct as a whitish fatty mass which, mixed with epidermal débris, forms the "*sebum.*"

3. *The Sweat or Coil-Glands.*—These are single tubular glands made up of (1) a *body* consisting of two or more turns, forming a coil situated in the reticular layer or subcutaneous tissue, and (2) a *duct* which traverses the corium in a spiral manner, passes through the epidermis, and opens on the surface at the sweat-pore.

These are present all over the body except on the glans penis, margins of the lips, and nail-bed. In a modified form they occur at the auditory meatus (ceruminous glands), in an elliptical ring round the anus (glands of Gay), and on the eyelids (glands of Moll).

Structure.—(*a*) *The coil or body* is composed of a single layer of cylindrical cells, which has a granular appearance when the gland is actively secreting, but which disappears when the gland is at rest. A layer of involuntary muscular cells encloses the cylindrical cell-layer.

The muscular cells are arranged longitudinally or spirally round the coil, and outside them there is a basement membrane and a fibrous capsule supporting blood-capillaries. The lumen of the distal portion of the coil is wider than that of any other part of the gland, and is known as the "*ampulla.*" Towards the duct the epithelium becomes more cubical, several layers may be present, and the muscular coat disappears.

(*b*) The *duct* in its spiral passage through the corium has a uniform calibre, and the lumen on section is stellate or forms a cleft. The tube is formed by several layers of cubical epithelium, inside which a cuticle and a connective tissue sheath have been described, but no muscular fibres. On reaching the epidermis the duct proper may be said to end, and in its further course it is represented by a spiral cleft between the prickle-cells and the horn-cells. It always passes up through an interpapillary process. The granular and horny layers, however, dip down into the Malpighian layer for a short distance to form a funnel for the duct. In its passage through the epidermis the sweat communicates freely with the intercellular lymph, and the latter finds an exit with the sweat at the pores.

4. *The Nails.*—The nails are inelastic, translucent, horny plates situated on the dorsum of the distal phalanges of the fingers and toes.

The *nail-plate* presents a posterior concave border, two almost parallel lateral borders, and a convex free edge. Its upper surface is convex transversely, and to a less extent longitudinally. The whitish semilunar area occupying the posterior fifth of the nail-plate is known as the "*lunule.*" The nails are bounded by *posterior* and *lateral nail-walls*, and from the former a thin crescentic membrane passes for a short distance over the lunule. The lateral walls are slightly divergent, and have a rolled appearance. The nail-plate passes for a short distance beneath the lateral walls, and for a greater distance under the posterior wall, where it is known as the *nail-root*, and is enclosed in

a structure analogous to the hair-follicle, called the *nail-fold.*

The *nail-fold* is split horizontally by the root into (1) an *upper portion*, forming a roof composed of the various layers of the epidermis, in which the continuation of the stratum corneum is in contact with the nail; and (2) a lower portion named the *nail-matrix.*

The *nail-matrix* is an important structure, as it is from it that the nail grows. It extends from the posterior extremity of the nail-fold as far forward as the anterior margin of the lunule. It is composed of a prickle-cell layer continuous behind with that of the roof of the nail-fold, and in front with that of the nail-bed. Above the prickle-cell layer there is a layer of several rows of flat granular cells with shrivelled nuclei, above which the true nail-cells begin to appear. It is the presence of these granules which gives the whitish opaque appearance to the lunule. Beneath the prickle-cell layer of the matrix there is a well-developed papillary layer in which the papillæ are arranged on parallel ridges suggesting cockscombs.

The *nail-bed* extends from the matrix almost as far as the free edge of the nail, and on it the nail-plate rests. There is, however, no organic connection between the nail-plate and the nail-bed. The latter is composed of a prickle-cell layer, beneath which is a papillary layer consisting of about sixty ridges parallel to the long axis of the nail. Under this there is a rich subpapillary vascular plexus, in which large venous sinuses are present, lined with endothelium, and forming an erectile tissue.

The *nail-plate*, though not in organic connection with the nail-bed, is in close contact with it, since on its under surface there is a series of parallel ridges which fit in between those of the nail-bed and so bind the two structures together. It is made up of flat cornified cells which differ from those of the stratum corneum in that the nuclei persist. These cells are arranged in superimposed lamellæ, which can only be distinguished near the nail-matrix, since further forward they become knit together to form an almost homogeneous plate.

Growth of the Nail.—If left uncut the nail does not grow indefinitely, but at a variable distance beyond the finger it becomes thin and desquamates, so that a natural free border is formed. As a rule the matrix only produces one nail, which during life is constantly growing at about the rate of 0·8 mm. in twenty-four hours on the fingers, while on the toes the growth is slower (0·4 mm.).

Blood-Vessels of the Skin.—There are the following systems of blood-vessels in the skin, which begin in the subcutaneous tissue, and pass towards the surface:—

(*a*) *Blood-Vessels of the Subcutaneous Tissue.*—Small arteries are present in the trabeculæ between the fat-lobes; certain branches from these (1) course in the septa between the lobules, to end in capillaries between the fat-cells, and (2) others pass up more or less vertically into the corium. Veins and venous capillaries correspond to these arteries.

(*b*) *Blood-Vessels of the Corium.*—Two somewhat horizontal vascular plexuses are generally described in the corium: a deep one situated next the subcutaneous tissue, and a superficial one in the subpapillary layer. From these plexuses branches are given off to the sweat-apparatus, pilosebaceous follicles, and the papillary layer. In the papillæ the capillaries form loops by the junction of a single or double arterial capillary with a venous capillary several times greater in diameter.

Throughout the corium the blood-vessels are of the nature of capillaries since they possess only an endothelial layer, and it is in the subcutaneous tissue alone that small arteries and veins occur in which a muscular wall and a tunica extima are present. The veins of the corium are considerably larger than the arteries.

Lymphatics.—In the skin there are comparatively few true lymphatic vessels with a distinct endothelial lining, but there are numerous spaces between the fibres of the corium and the cells of the epidermis which serve the purpose of lymphatics.

(*a*) The *lymphatic vessels* begin as blind ends in the papillæ, pass down to a lymphatic plexus in the subpapillary layer, and then course obliquely through the corium, accompanying the blood-vessels, to be collected into the larger lymphatics of the subcutaneous tissue. The lymphatic vessels of the papillæ are most easily seen in the large papillæ of the fingers and toes. The lymph from the tissue-spaces gains entrance into the vessels either through stomata or between the endothelial cells.

(*b*) The *lymphatic spaces* are not lined by endothelium. They are present between the fibrous bundles of the corium, around the coils and ducts of the sweat-glands, between the epidermal cells of the hair-follicles and sebaceous glands, around the arrectores pilorum, and between the prickle-cells of the epidermis. They pour their contents partly into the lymphatic vessels and partly into the veins.

Nerves.—Both medullated and non-medullated nerve fibres are present in the skin: (*a*) The *medullated* fibres form plexuses in the corium, from the most superficial of which fine non-medullated fibres pass between the prickle-cells of the epidermis, forming the *interepithelial plexus.* Medullated fibres also pass to the connective tissue coats of the hair-follicles; there they lose their sheaths and split into fibres which form a plexus between the epidermal cells of the external root sheath. A few of the medullated fibres terminate in special end-organs.

(*b*) The *non-medullated fibres* probably supply the arrectores pilorum, the sweat-coils, and blood-vessels.

The *interepithelial* nerve plexus is composed of fibres which have lost their medullary sheaths in the subepithelial layer. These are distributed between the prickle-cells as far as the stratum lucidum. They end in minute swellings between the cells (Klein), or, according to Unna, pass into the cells and terminate in swellings applied to the nuclear membranes. The fibres of the epithelial plexus are sensitive to touch-impressions and to common sensation.

Special Terminal Corpuscles.—A few of the medullated fibres terminate in one or other of the following end-organs:—

(*a*) *Tactile Corpuscles, or Meissener's Bodies.*—These end-bulbs are situated in the papillæ, are universally distributed, but are specially numerous at the tips of the fingers and toes. They are oblong or spindle-shaped, and present a transversely striate appearance, owing to their being composed of superimposed layers of connective tissue between which the nerve fibrils ramify and end in small swellings. The nerve loses its medullary sheath on entering the corpuscle and splits into these fibrils.

(*b*) *Touch-Cells of Merkel.*—These are peculiar, small, round, or pear-shaped cells situated at the termination of the medullary nerves of the papillæ of the fingers and toes. Certain observers believe them to be epithelial cells, and do not regard them as sensitive.

(*c*) *Pacinian Bodies, or Corpuscles of Vater.*—In unstained sections held over a dark background these bodies appear as small milky specks situated in the subcutaneous tissue. They are most numerous on the palms and soles; they are oval or elliptical in shape, and are made up of a cortex of concentrically arranged connective tissue capsules like the sheaths of an onion, and a central granular core in which the fibres of the axis cylinder of the nerve terminate in a group of pear-shaped swellings. The nerves immediately below the corpuscle form a swelling known as the "stalk," and the capsules are said to be due to a splitting up of the sheath of Schwann of the nerve. The Pacinian bodies are believed to be sensitive to pressure and traction.

Muscles of the Skin.—These consist of the *arrectores pilorum* and *layers of involuntary muscle* fibres such as are found in the areolæ of the nipples, the dartos of the scrotum, and the eyelids.

The arrectores pilorum are made up of involuntary muscular fibres which arise from a neighbouring papilla, and are inserted into a projection situated in the middle third of the hair-follicle. On contracting they cause an erection of the hair, and at the same time a dimpling of the surface of the skin. The elastic tissue forms a framework for the muscle which is continuous with the elastic network of the corium, so that when the muscle contracts it causes an increased tension of the skin in the neighbourhood.

Pigment and Colour of the Skin.—In white races very little pigment is present in the skin except in the pigmented regions, such as the areolæ of the nipples, axillæ, scrotum, around the anus, and in the hairs. The colour of the skin is, as a rule, more dependent on the subcutaneous fat and the degree of vascularity than on pigment.

The pigment granules are situated chiefly in the epithelial cells of the basal layer of the epidermis. They are generally confined to the periphery of the cells, while the nucleus and the zone immediately around it are free from pigment. They may also occur in the interepithelial lymphatic spaces, where they form branching figures. They are sometimes present in the deeper cells of the Malpighian layer, and more rarely in the connective tissue cells of the papillary layer.

In dark races the pigment extends up as far as the granular layer of the epidermis. The true pigment of the skin—in contradistinction to blood-pigment, which gives the skin its peculiar tints in bruises and purpura—consists of a substance called *melanin*, which is in the form of more or less fine, irregular, brownish-black granules. Unlike the blood-pigment it is never in the form of crystals, and contains no iron. It is soluble in ether, weak acids, alkalies, and hydrogen peroxide, and is bleached by chlorine

Physiology

The skin performs six important functions: 1. It regulates the body temperature; 2. It is a respiratory organ; 3. It is a secretory organ; 4. It is a sensory organ; 5. It is a protective organ; 6. It has a limited power of absorption.

1. *The Function of Heat-Regulation.*—The constant temperature of the body is maintained by the heat-regulating function of the skin. The amount of heat which is lost from the surface of the skin by radiation, conduction, and evaporation depends chiefly on the state of dilatation of the cutaneous vessels and on the activity of the sweat-glands. Heat and cold cause respectively a dilatation or constriction of the cutaneous vessels, either by acting directly on the involuntary muscular fibres of those of the subcutaneous tissue, or indirectly through the vaso-motor centres. In this way an increase in the flow of blood to the skin is determined, and a cooling results.

Heat causes an increase in the excretion of sweat by a reflex and central stimulation of the glands, and through evaporation of the sweat a certain amount of heat is rendered latent, and the blood is cooled.

The involuntary muscles of the skin also

assist in performing this function, since cold stimulates them to contract, and so the superficies is reduced and the loss of heat by conduction and radiation is diminished.

2. *The Function of Respiration.*—The skin is capable of eliminating water-vapour and carbonic acid gas, and possibly of absorbing oxygen. The amount of water excreted by the skin in twenty-four hours is almost double that which is eliminated by the lungs. An increase of the temperature of the air causes an increase in the amount of water and carbonic acid gas excreted by the skin.

3. *The Function of Secretion.*—The fluid secretions of the skin are the sweat and the sebum.

(*a*) *The sweat* is a watery, clear fluid, with a saltish taste, a peculiar odour, and an acid reaction due to the presence of acid sodium phosphate, except in excessive sweating, when the reaction becomes alkaline. It contains water, salts, fats, volatile fatty acids, cholesterin, and a trace of urea.

The excretion of sweat is dependent on two sets of nerves, namely, special excretory nerves, and the nerves of the involuntary muscles of the coils. Special sweat-centres are present in the cord and medulla.

The excretion of sweat is stimulated—(1) peripherally by certain drugs, such as pilocarpine and muscarine; and (2) reflexly and centrally by heat, a venous state of the blood, and such drugs as strychnine; the excretion is diminished by atropine. The sweat not only eliminates certain effete products from the blood and lymph, but it lubricates the skin.

(*b*) *The sebum* is a semifluid substance containing various fats, fatty acids, cholesterin, salts, albuminoids, and water mixed up with epidermic débris and a few horn-cells. No excito-secretory nerves have been demonstrated in connection with the sebaceous glands.

The old view that the sebum was mechanically secreted by pressure caused by the contraction of the arrector pili is no longer admitted, and the secretion is now believed to be due to the *vis a tergo* caused by the continuous elaboration of fat by the sebaceous cells. The secretion of sebum is augmented by an increase in the temperature and the blood-supply to the gland. The function of the sebum is to lubricate the hair.

4. *The Sensory Function.*—The presence of the peripheral nerve terminations in the skin makes it sensitive to touch, common sensation, pressure, and traction.

5. *The Protective Function.*—The waxy fat in the stratum corneum gives to the skin the character of a waterproof coating for the body, and also prevents too great evaporation and absorption of toxins or poisonous gases; the close union of the cornified cells enables the skin to resist mechanical injuries, and prevents the entrance of micro-organisms.

6. *The Function of Absorption.*—As long as the stratum corneum is intact the skin has little absorptive capacity, but if it be abraded absorption by the papillæ readily takes place.

Neither water nor alcohol, nor substances dissolved in them, are absorbed by the healthy skin, except at the mouths of the follicles and sweat-pores.

On the other hand, oils and fats and substances suspended in them are absorbed, and the more nearly allied the fat is to that of the skin the more active is its absorption. The degree of absorption of substances suspended in fats depends on their power of becoming volatilised at a low temperature. If the skin-fat be removed by washing with ether, absorption by the skin takes place more readily. Gases are also absorbed by the unbroken skin.

Bacteriology of the Skin

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General Introduction. — The more exact our knowledge of dermatology becomes the greater is the rôle which micro-organisms are found to play in its etiology. Within recent years a number of skin diseases which had previously been vaguely considered to be the result of some peculiar diathesis or idiopathy, have been definitely proved to be parasitic in their origin. Still, in spite of the recent elaborate researches and the extensive literature which has collected around the subject, our knowledge of the dermatological flora is very far from being complete. Sabouraud has aptly compared it to an ancient map in which the large countries alone are mapped out, while all within the lines enclosing them is blank and unknown. The study of the bacteria of the skin is complicated and difficult. At one time or another any micro-organism may become deposited on the skin, so that a complete description of the subject would necessitate a reference to almost every known variety of bacterium. Micro-organisms are found in largest numbers in those regions of the skin which are least exposed to friction, such as the axillæ, the groins, and the clefts between the fingers, and where the sebaceous glands, which form a suitable soil for the growth of most micro-organisms, are in greatest profusion.

For purposes of description the micro-organisms of the skin may be divided into two classes, namely, those which are accidentally deposited on the surface and as a rule do no harm, and those which are invariably present, and which find a suitable habitat in the stratum corneum and about the epidermal appendages. The latter class of bacteria as a rule lead a perfectly

harmless saprophytic existence on the skin, but a number of them may, under altered circumstances, so proliferate and increase in virulence as to become pathogenic. For example, the staphylococcus epidermidis albus of Welch, which is one of the most constant of all the denizens of the skin, though usually harmless and saprophytic, may, by being passed through animals, assume virulent properties indistinguishable from those of the staphylococcus pyogenes albus. Similarly, the streptococcus pyogenes is generally admitted to be a less virulent condition of the streptococcus erysipelatis. Several bacteriologists have attempted to classify the various species of bacteria which are generally present in the healthy stratum corneum, and complicated lists of them have been published; but these differ to such an extent in the number of the organisms included, and in the types which are regarded as pathogenic, that they are of comparatively little value, and they only serve to emphasise the difficulties of the subject. These difficulties are in great part due to the fact that it is almost impossible to draw a hard and fast line between bacteria which are slightly pathogenic and those which cause no apparent disturbance. At the present time the confusion is increased by the endeavour on the part of several well-known observers to find specific pathogenic characteristics in almost every micro-organism which they find on the skin, and the equally strenuous effort on the part of others to limit the number of specific micro-organisms by simply regarding the majority of them as different stages of a few polymorphic types.

It will be possible here to refer to only a few of the bacteria which are commonly found in the healthy epidermis, and to the most important of those which are pathogenic and cause various forms of dermatitis.

For purposes of convenience the latter will be described under the heading of the diseases with which they have been identified, arranged in alphabetical order.

Bacteria present on the Healthy Skin.—A list of the bacteria which may be present on the healthy stratum corneum, and which lead there a saprophytic existence, either owing to their occurring in small numbers, or being in a state of diminished virulence, would of necessity be a long one. Only a few of the more common of these need be mentioned.[1]

Bacillus epidermidis: obtained from the skin between the toes, and from the epidermic scales (Bordoni-Uffredezzi).

Bacilli: 2·8 μ to 6·3 μ in length, and 0·3 μ in breadth; grow slowly on gelatine and do not liquefy it; aerobic.

Bacillus epidermidis capsulatus: obtained by Damman from scrapings of the skin between the toes.

Bacilli: large, motile, with rounded ends, and generally occurring in pairs; capsule forms in gelatine cultures; on gelatine it grows in irregularly shaped bluish colonies, which evolve gas and emit a peculiar odour.

Bacillus fluorescens epidermidis: obtained by Damman from the tip of the finger after thoroughly washing with absolute alcohol.

Bacilli: motile, usually arranged end to end in pairs; liquefy gelatine rapidly with fluorescence, the liquefied gelatine showing an upper green layer and a lower fluorescent one. This bacillus resembles, if it be not identical with, B. fluorescens liquefaciens of Flugge, and the B. fluorescens liquefaciens minutissimus of Unna.

Bacillus gelatinosus: obtained from the skin between the toes.

Bacilli: slender, motile, with distinct capsule and often beaded like tubercle bacilli; gelatine cultivations produce a colourless transparent gelatinous material, which being incorporated with the purely chromogenic organism has a granular or mottled appearance; plate-colonies are rusty brown in colour on microscopical examination, and yellowish to the naked eye.

Bacillus graveolens: obtained from between the toes (Bordoni-Uffredezzi).

Bacilli: short, liquefy gelatine, and give off a fetid odour like that of the feet.

Bacillus aureus: described by Tommasoli as occurring in the epidermis.

Bacilli: slightly bent; 1·5 μ to 4 μ in length, and 0·5 μ in breadth; arranged parallel in pairs or groups; grow on gelatine as irregular whitish yellow colonies, and do not liquefy it.

(The same observer describes 6 bacilli, 10 cocci, and 6 yeasts as being present in any scale from the epidermis.)

Micrococcus fluorescens subsidens: obtained from the healthy epidermis.

Micrococci: in irregular groups or short chains; form pale yellow creamy colonies on gelatine; do not liquefy it.

Staphylococcus epidermidis albus of Welch: the most constant denizen of the skin; closely resembles S. pyogenes albus, except that it is much less virulent; liquefies gelatine more slowly, and coagulates milk more feebly; is generally regarded as a less virulent stage of the ordinary white staphylococcus; is the same as the S. cutis communis of Sabouraud; on gelatine it forms opaque whitish colonies like porcelain, with irregularly rounded edges; on agar the colonies are generally smaller than those of the S. pyogenes albus.

Polymorphic coccus of Cedercreutz: assumes different appearances according to the medium on which it is growing, the temperature, and its state of virulence; said by Cedercreutz to have been variously described as the morococcus

[1] For a more extended list, see Galloway's article in Allbutt's *System of Medicine*, to which the writer is indebted for much assistance in preparing this article.

(Unna), S. cutis communis (Sabouraud), and S. epidermidis albus (Welch), and under different circumstances by "Demme (1886), Claessen (1893), Bulloch (1895), Whipham (1886), Berholm (1900), and Whitfield (1900)." On ordinary gelose it may "assume all tints, from a milk-white to a golden yellow, and on gelatine the culture presents a canary yellow colour." It prefers slightly acid or neutral media. As a rule it neither liquefies gelatine nor coagulates milk; it varies considerably in size and form, and may assume a flask-shape ("flask-shaped bacilli"); it frequently occurs as diplococci.

Staphylococcus flavescens: obtained by Damman from the skin of the toes and genito-crural folds.

Staphylococci: form yellowish colonies; begin to liquefy gelatine in three to six days.

Bacteria identified with various Diseases of the Skin.—Acne Vulgaris.—The formation of the acne pustule is always preceded by the plugging of the pilo-sebaceous follicle by a comedo.

1. Bacteria found in the comedo.

(*a*) *Microbacilli of Sabouraud and Unna and Bacillus acnes of Gilchrist.*

Believed by these observers to be the specific cause of the comedo, and by Unna to have pyogenic properties in addition.

Microbacilli: 1·25 μ to 1·5 μ in length, and 0·3 μ to 0·5 μ in breadth. Assumes two forms: (1) young bacilli, resembling cocci, ovoid or barrel-shaped, with a capsule, and (2) old bacilli, longer, sigmoid, united in chains or arranged in bundles; stain with Gram's method. On Sabouraud's special medium colonies develop on the fourth day, and twenty hours after take the form of brick-red cones; frequently grow in association with S. cutis communis, but in twenty-eight days the porcelain-like culture of the staphylococcus dies, and that of the microbacillus remains pure; inoculations on the skin from cultures gave negative results.

(*b*) *Flask-shaped bacilli:* B. asciformis, Balloon bacillus (Hodara); B. bouteille (Sabouraud); situated about the head and mantle of the comedo; they invariably grow in association with the S. cutis communis, and it has been suggested that they are degenerate involuted forms of that micro-organism.

Bacilli: generally gourd- or flask-shaped, with a large spherical portion surmounted by a small rounded process, but they may be oval, round, barrel-shaped, or thread-like; 5 μ in length or longer; arranged usually in groups, stained by Gram's method; in fluid media they form a deposit like sand, and on solid media they grow as whitish radiate colonies.

(*c*) *Diplococci, small cocci* which do not liquefy gelatine, *large cocci* which liquefy it, and *S. epidermidis albus* have also been described in comedones.

2. Bacteria found in the acne pustule: *Staphylococcus pyogenes albus, aureus,* and *various torulæ.*

Acne necrotica seu varioliformis: (*a*) *Microbacilli (Sabouraud);* (*b*) *S. pyogenes aureus.*—The microbacilli, according to Sabouraud, are only present in the initial stage of acne necrotica, and the peculiar necrotic pustule is believed by him to be due to the symbiosis of both these micro-organisms.

Alopecia Areata.—The parasitic organ of at least one type of alopecia areata has recently been strongly advocated, namely, the type in which the early lesions appear as small pinkish inflammatory patches, dotted over with seborrhœic plugs, and frequently associated with pityriasis of the scalp.

Sabouraud has isolated fifteen species of micro-organisms from such a case, one of which, the *microbacillus* (*vide supra*), he considers to be specific. Though several experiments have been recorded where bald patches are said to have appeared after the subcutaneous inoculation of microbacilli, the evidence is not yet sufficient to be convincing.

Norman Walker planted stumps from a number of cases of alopecia areata on Sabouraud's medium, but with one exception, in which he obtained a brick-red culture of microbacilli, all the hairs grew porcelain-like cultures of S. epidermidis albus.

Carbuncle, due to the *ordinary pyogenic cocci: Staphylococcus pyogenes aureus; Staphylococcus pyogenes albus; Staphylococcus pyogenes citreus; Streptococcus pyogenes.*

Chancroid, or ulcus molle: said by Ducrey to be due to a streptobacillus.

(1) *Streptobacillus of Ducrey:* 1·4 μ long by 0·5 μ broad; round-ended; generally arranged in chains, decolorised by Gram's method; grows on a mixture of human blood serum and agar (Petersen), and on blood-gelose in the form of shining whitish colonies; experimental inoculation of four cases by Besançon gave positive results.

Unna has described a streptobacillus as specific which is similar to that of Ducrey; other observers deny that the streptococcus has specific characters.

(2) *Ordinary pyogenic cocci.*

Cheiro-pompholyx, or Dysidrosis: now generally believed to be due to a parasite; Unna has described a peculiar *bacillus* which he claims to be specific.

Bacilli: 2·5 μ to 3·5 μ in length, and 0·5 μ in breadth; arranged singly in groups of four to six, or on short threads; flourishes in sweat.

Ecthyma: due to the inoculation of pyogenic cocci in badly nourished and weakly resistant individuals. In one case of ecthyma térébrant, B. pyocyaneus was identified (Ehler's).

Eczema.—There are at present two opposing views regarding the origin of true papulo-

vesicular eczema, which may be termed the amicrobic and the microbic theories. According to the former view the vesicles of eczema are at first sterile, and only become invaded secondarily by pyogenic organisms, though it is generally admitted that the latter play an important part in the complete evolution of the lesions; and according to the second theory, eczema is a local parasitic disease due to the action of one or several micro-organisms. Moberg and Unna have isolated twenty-three different varieties of cocci from the skin in a series of cases of eczema including eczema seborrhoicum, of which twelve were harmless and eleven pathogenic: two of these were capable of producing eczema by inoculation on the human skin. Flask-shaped bacilli are frequently present. Other observers consider eczema to be simply due to staphylococci (Bockhart, Bender, Gerlach). Staphylococci producing white cultures have been isolated by Galloway and Eyre from four cases of acute papulo-vesicular eczema.

Eczema Seborrhoicum or Seborrhœic Dermatitis—Numerous micro-organisms have been identified with this condition, the most constant being the *S. epidermidis albus* and the *flask-shaped bacilli*. Unna described a peculiar coccus which from its grouping he named the "morococcus." This organism is now generally admitted to be identical with the S. epidermidis albus. Owing partly to its confused terminology, this subject is at present in a too chaotic condition to demand more than a passing reference.

Erythema nodosum: Demme's *bacilli* and various *cocci* have been detected in the blood.

Bacilli of Demme: 2·2 μ to 2·5 μ in length, and 0·5 μ to 0·7 μ in breadth; rounded ends; stained by Gram's method; inoculated on the skin or injected into the blood of guinea-pigs, it produced an eruption resembling E. nodosum, which was followed by gangrene.

Frambœsia, *see* Yaws.

Furunculosis: due to the organisms of suppuration.

Gangrene: several micro-organisms have been identified in the various forms of gangrene. Veillon and Hallé isolated a *bacillus* from the pus of an unopened abscess in a case of disseminated gangrene in a child.

Bacilli: about the size of the Klebs-Lœffler bacillus of diphtheria; straight or slightly curved; often arranged in pairs like a **V**; grow on agar in the form of greyish white colonies which emit a sour smell; identical with the B. ramosus of Veillon and Zuber. A somewhat similar bacillus was detected by Matzenauer in hospital gangrene. Other micro-organisms occur, namely *streptococci*, *staphylococci*, and *B. pyocyaneus*.

Impetigo.—(*a*) Simple impetigo is due to the inoculation of virulent pyogenic micro-organisms on any abraded or weakly resistant portion of the skin.

(*b*) Impetigo of Bockhart is a follicular disease due to the inoculation of the hair-follicles with *staphylococci*.

(*c*) Impetigo contagiosa is believed to be due to *streptococci*, and the presence of staphylococci in the lesions is regarded as a secondary contamination (Sabouraud, Gilchrist, Balzer, etc.).

Leprosy: most probably due to the *B. leprœ* of Hansen.

Bacilli: 5 μ to 6 μ in length, and 1 μ in breadth; closely resemble tubercle bacilli, but are less curved and more pointed; stain like tubercle bacilli; they have not been successfully cultivated outside the body, and inoculation experiments, except in a few doubtful instances, have given negative results; occur in the granulomata of leprosy, in old lesions of anæsthetic leprosy, and in nearly all the tissues of the body except the muscles, joints, and spinal cord.

Mycosis fungoides: numerous cocci and bacilli have been identified in the breaking down lesions, but these have probably no causal relation to the disease. M'Vail, Murray, and Atkinson have isolated a peculiar small *bacillus* in their case.

Bacilli: 1 μ to 2·5 μ in length, and 0·75 μ in breadth; single or in pairs; sluggishly motile; stained by Gram's method; aerobic, with difficulty anaerobic; grow in agar in the form of creamy white colonies, from the margin of which short, fine, hair-like rays penetrate into the medium; liquefy gelatine; subcutaneous injection in rabbits causes death in twelve to sixteen days, bacilli being found in the enlarged lymphatics.

Pemphigus.—Acute pemphigus: Pernet and Bulloch have isolated *diplococci* from the bullæ.

Diplococci: about one-half longer than a gonococcus; grow on blood serum with characteristic colonies; pathogenic to rabbits. Dähnhardt has identified a similar diplococcus in chronic pemphigus.

In pemphigus neonatorum the ordinary pyogenic cocci are present in large numbers.

Purpura: numerous micro-organisms have been described in the dilated vessels in P. hæmorrhagica, for example *streptococci*, *pneumococci*, and *B. coli communis*. In a fatal case Klob described a short oval *bacillus* (*Bacterium hæmorrhagicum*).

Bacilli: 0·8 μ to 0·5 μ in length, and 0·4 μ to 0·8 μ in breadth; arranged in pairs; not motile; grow slowly on gelatine without liquefying it, forming whitish colonies; produced purpuric lesions when inoculated on mice, guinea-pigs, and dogs.

Pyodermia: due to the *pyogenic cocci; S. pyogenes aureus*, *albus*, *citreus*, *cereus albus*, and *cereus flavus; streptococcus pyogenes;* and occasionally *B. pyocyaneus* and *B. coli communis*.

Rhinoscleroma: specific short *bacillus* described by v. Frisch.

Bacilli: 2 μ in length, and 0·5 μ in breadth; rounded ends; enclosed in a gelatinous capsule; arranged singly or in characteristic groups lying in a glœa; situated in the protoplasm of Mikulicz's cells, or free in the lymph spaces; form shiny pin-head colonies on gelatine, and do not liquefy it; pathogenic to mice and guinea-pigs, but did not cause rhinoscleroma when inoculated.

Seborrhœa oleosa: considered by Sabouraud to be due to the *microbacillus*.

Syphilis: various micro-organisms have from time to time been described in connection with the lesions of syphilis, and several have been put forward as the specific cause of the disease. Bacilli have been described by Lustgarten, Jullien, v. Niessen, and others, and cocci by Disse and Taguchi. Of these micro-organisms the best known is Lustgarten's bacillus.

Bacilli: 3·5 μ to 4·5 μ in length, and 0·28 μ in breadth; straight or curved, ends clubbed; stain by Zelh-Neelsen's method; resemble the smegma bacilli; have not been successfully cultivated outside the body.

[The spirochæte pallida is now generally recognised as the microbic cause of syphilis.]

Trichorrhexis nodosa: Hodara and Spiegler have identified peculiar *bacilli* in the shafts and follicles of the affected hairs.

Bacilli: 1 μ to 6 μ in length or longer, and 0·3 μ in breadth; rounded ends, stained in the hairs by aniline gentian-violet and by the other methods for staining the fungi of ringworm in the hairs; grow on agar in the form of small, round, whitish grey colonies which tend to become confluent; liquefy gelatine slowly; inoculation from cultures produced the disease in previously healthy hairs.

Raymond has described a *diplococcus*.

Tuberculosis cutis: due to Koch's *tubercle bacillus*. It has been found in lupus vulgaris, tuberculosis verrucosa cutis, and erythema induratum—Bazin.

Yaws: several micro-organisms have been isolated in association with the lesions of yaws, and have been regarded as specific by those who described them; but specific characters have not been definitely established in any of them. Among these are a *yeast* (Powell), a *bacillus* (Breda), and a *micrococcus* (Nicholls and Watts).

Diseases of Sweat and Sebaceous Glands

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Diseases of the Sweat or Coil Glands.—It is now generally admitted that these glands excrete an oily fluid as well as the saline fluid known as sweat. On certain regions of the skin—notably on the palms and soles—they alone are concerned in the lubrication of the skin so very necessary in these situations. It is probable that a deficiency in this oily excretion has a more important connection with many diseases than has hitherto been supposed.

Certain definite organic diseases are sometimes, though rarely, observed. Cysts may form deep down in the course of the duct (hydrocystoma), and suppuration occasionally occurs (hydroadenitis). Localised suppuration in a sweat gland is probably the starting-point of boils in the axillary region, where the glands are especially large.

Sudamina or *crystallina* is the term applied to the lesions produced in certain diseases accompanied by excessive sweating. The sweat pore is obstructed at its outlet, and the result is the appearance on the skin of a clear vesicle, which looks like a drop of free fluid, but which, when touched, is found to be covered by an extremely thin layer of horny cells.

Miliaria, which is often confused with this condition, is a form of inflammation of the skin, and should not be classed among the diseases of the sweat glands.

The functional diseases are the more common and the more important.

Hyperidrosis, or excessive sweating, in its generalised form, is a frequent accompaniment of constitutional diseases, especially certain fevers, in which case it is, of course, of secondary importance. It is also sometimes influenced by nerve impulses, in which case it may be distributed over the area of a particular nerve, and is therefore frequently unilateral. There is often general sweating in anæmia, and in some cases of hysteria, while in alcoholism the skin often has a damp, clammy feeling from excessive secretion of sweat.

Certain regions of the body are, however, specially liable to *localised hyperidrosis*. These are the scalp, especially in premature alopecia, the axillæ, the groins, and the hands and feet. The secretion may be so abundant, especially in the last two situations, as to lead to maceration of the epidermis. The skin, consequently, is easily irritated, and inflammation and fissuring often occur.

In many cases of excessive secretion the odour is unpleasant, but in a certain proportion the odour becomes unbearable, and thoroughly deserves the name of bromidrosis (*βρὸμος*, a stench). This change is due to the growth of bacteria in the sweat. When the condition affects the feet, owing to the method of foot-gear generally in vogue, the parts are shut up, and the symptoms are aggravated, the skin often becoming so tender that walking is

impossible. It seems probable that the bacteria present upon the surface in some way stimulate the glands to continued and increased secretion, this being especially likely on the palms and soles.

Treatment.—The general health of the patient should be carefully attended to, and all abuses stopped. Anæmia should be corrected by the administration of iron, and other constitutional diseases should be appropriately treated.

The drugs which have a repute for checking the secretion of sweat are, curiously, of comparatively little value in this condition. Atropin and belladonna, agaricin and such like, usually disappoint the administrator. According to Crocker, sulphur administered in large and repeated doses has a distinctly beneficial effect. The local treatment consists in rigidly enforcing the most scrupulous cleanliness—the parts being washed, if necessary, several times daily—and dressings being applied, if necessary, so as to soak up the fluid as it is exuded, and prevent it from causing maceration of the skin. For axillary hyperidrosis frequent bathing with very hot water is often successful; it generally checks the secretion for a time. The hands and feet may be treated by causing exfoliation of the epidermis, by the use of salicylic acid, resorcin, or some other reducing agent. This is always followed by some improvement, but unless treatment is continued relapse is inevitable.

In *hyperidrosis pedum* it is a very common practice to advise repeated bathing and changing of the socks, which before they are put on should be powdered with a mixture of boric acid and powdered talc. Other applications are solutions of chromic acid, which hardens the skin, perchloride of iron, nitrate of silver, alum, etc. The feet are often cold, and means should be taken to improve the circulation in them by exercise, the wearing of woollen socks, and easy shoes. Tar is a remedy which possibly is not sufficiently used in this disease; if the skin will stand strong solutions painted upon it, marked improvement often follows.

Neebe recommends a very heroic treatment in advanced cases, which consists in patients standing for some seconds in a flat dish which contains just enough hydrochloric acid to cover the soles of the feet, which are the regions specially affected. The feet are then bathed in an alkaline solution and dressed with some soothing ointment.

Chromidrosis, or coloured sweat, should always be regarded with scepticism. One or two authentic cases have been recorded where the sweat has been stained blue, after excretion, by the growth of the bacillus pyocyaneus, and instances are frequent where the underclothing covering the axillary region is stained red. If in such cases the hairs in the axillæ are examined, they will usually be found to be sheathed with a dull substance which consists largely of bacteria, and the red staining is brought about by these bacteria. The only cure for this condition, which is very obstinate, is shaving, and the constant and prolonged application of antiseptics to the part.

It is said that green sweat is occasionally seen in those who work in the manufacture of the copper salts.

Hæmidrosis, or bloody sweat, is extremely rare, and any supposed cases should be investigated most strictly. Possibly the sweat may be slightly blood-stained in hæmophilia.

Seborrhœa.—The derivation of this name from *sebum* and *ῥέω*, to flow, shows that it is, etymologically, an incorrect term, and the word stearrhœa has been suggested in its place. The word, however, has the general approval, and is not likely to be displaced. It was originally applied when the scales found on the scalp were supposed to be dried-up sebaceous secretion, and the name remained when that was shown to be incorrect.

Recently Sabouraud has harked back on the ancient meaning of the word, and has sought to use it as an argument for his theory of the disease. It is therefore desirable to clear the ground, and to define the different meanings attached to the same term by the two most prominent German and French observers, Unna and Sabouraud.

Sabouraud regards seborrhœa as a disease produced by the presence of an organism, which structurally is a fine bacillus, in the mouths of the sebaceous glands. This organism, he holds, stimulates and alters the character of the excretion of the sebaceous glands, so that it becomes more fluid. When the stimulation stops there, and there is merely an increased supply of grease on the surface of the skin, he applies to it the old term of seborrhœa oleosa. In many cases, however, a further effect is produced, the mouth of the gland is plugged completely by a horny concretion, and the disease becomes that generally known as acne.

Sabouraud further holds that the disease known as alopecia areata is caused by the growth in the hair follicles of this same bacillus.

Unna, who was the creator of the term seborrhœic eczema, holds views entirely different from those of Sabouraud. According to him the scaling of the scalp, to which our predecessors attached the term seborrhœa sicca, is the prototype of the disease.

The scalp is peculiarly tolerant of irritation, and active counter-irritants applied to it often produce only a slight amount of scaling, while on the smooth skin they would produce a vesicular eruption or an actual blister. Unna suggests that this scaling is due to some organism, and as the most likely of these he

selects the organism to which he has given the name of the *morococcus*. In the scalp, however, organisms are so numerous that it is extremely difficult to identify any one as the cause of a disease.

From the scalp, where it originates, the disease spreads to other parts of the body. Sometimes it spreads upon the forehead, where there is at once shown the difference in the reaction of the skin, for the eruption on the forehead shows by its hyperæmia much greater evidence of reaction of the skin than does that upon the scalp.

Other common seats of the disease are the sternal and interscapular regions, where the eruption takes a ringed form, and is often confused with ringworm. Behind the ears, where the skin is peculiarly thin and intolerant, the reaction is great, and fluid is frequently exuded upon the surface, so that in this region the eruption is moist. The flexures, too, are often affected, and in the axillæ and groins the circinate character of the eruption and the resemblance to ringworm is often pronounced. All these eruptions on the body have associated with them a peculiar yellow colour, most marked in the centre of the patch, and Unna suggests that that is due to stimulation of the sweat or coil glands, which excrete fatty substances to a greater degree than they normally do.

Herein, indeed, lies one of the main differences between Unna and Sabouraud; for Sabouraud does not appear to attach any importance to the oily secretion of the sweat glands, while he regards dandruff, which has all along been regarded as synonymous with dry seborrhœa, as a totally different disease, for which he suggests the use of the old name of pityriasis. It is one of the difficulties of dermatology that its exponents have too often felt constrained to endeavour to fit new theories on to the old names.

When the eruption spreads, as it not infrequently does, to the limbs, the tendency to the exudation of fluid becomes much less. There is but little evidence of any increased secretion of oil, and the spots, usually rounded, are pink in colour, are covered with silvery scales, and are indeed in the opinion of many, including the present writer, indistinguishable from the lesions of psoriasis. This, however, is hardly the place to discuss this modern doctrine.

On the scalp one of the commonest results of seborrhœa is alopecia, and the term of alopecia præmatura is practically synonymous with that of alopecia seborrhoica. It would seem that when the coil glands are stimulated along with the epidermis, there is not the same tendency to alopecia. It is the dry form of inflammation which leads to the casting of the hair, and to its succession by a less perfect one; and this process continually going on results in conversion of the ordinary hair of the scalp into a fine down.

Another disease which is in all probability connected with seborrhœa is that known as rosacea. While that disease has long been associated with, and is undoubtedly aggravated by digestive disturbances, flushings, etc., it will be found on careful examination that dry seborrhœa of the scalp is present in the majority of cases, and it is suggested that the scales falling from the scalp on to the face irritate the skin, and lead to its reacting with hyperæmic dilatation of the vessels, and the formation of pustules on the central region of the face, in the manner which is associated with this disease.

Treatment. — The successful treatment of seborrhœa depends on the recognition of the all-important fact, that the disease commences, and has its most important seat in the scalp; and the disease on the body, though it is more easily got rid of, will inevitably return unless the scalp is brought into a healthy condition. This is best attained by frequent washing, and for that a fluid soap is to be preferred to a hard one. The well-known Hebra's soap spirit, which consists of two parts of soft soap and one of spirits of wine, is certainly as efficacious as any.

The head should be wet with warm water, then some soap spirit poured directly on the scalp, which should be vigorously shampooed for five minutes, thereafter the lather must be thoroughly washed out and the head dried. Females often complain that the proceeding is very irksome, and that the hair is apt to be matted after its use. This, however, is generally owing to the fact that the soap has not been thoroughly washed out of the part. In slight cases the repetition of this twice a week will suffice to keep the disease under, and eventually to cure it; but if the disease is more severe, further means must be employed.

There are two drugs which have a very marked influence on the catarrh of seborrhœa, viz. sulphur and salicylic acid, and they may be applied to the scalp in a very much more concentrated form than they can to the rest of the body. Indeed it is usually necessary to warn the patient that the hands must be washed immediately after making the application, for if an ointment of say 10 per cent salicylic acid is applied with the fingers, these very soon show signs of its action in persistent desquamation.

A useful application for ordinary cases consists of half a drachm each of sulphur and salicylic with 1 oz. of vaseline. The modification of vaseline known as vasol, which is an oily-looking fluid, may be used instead of vaseline. It is more easily rubbed in, and is not so greasy as the ordinary preparation.

For the eruption on the body washing is

generally indicated, but the application must vary with the form of inflammation with which the skin reacts. Thus if the eruption is moist, powders or pastes are to be preferred to ointments, and if the eruption is very widespread a lotion may be used. As already indicated, the smooth skin will not stand the same strength of application as will the scalp, and from ten to twenty grains of each of the preparations is probably as much as is generally useful. In the drier forms of the eruption sulphur does not seem to suit so well, and should be omitted from the prescriptions in such cases.

Treatment must be kept up for a considerable time after the disease has apparently disappeared, otherwise relapses will occur.

In *alopecia seborrhoica* the treatment already recommended for seborrhœa is generally the most efficacious. The cure of the disease which is producing the baldness is of much greater importance than the stimulation by mild counter-irritants often advised, for the skin is already sufficiently stimulated by the disease.

In *rosacea* the treatment of the scalp is of primary inportance. Indeed it is even possible to leave the face altogether alone and yet get a good result. Recovery, however, is hastened by simultaneous treatment of the eruption on the face by a lotion containing sulphur and some bland powder, such as calamine and oxide of zinc, made up so as to form a pretty thick lotion. Glycerine is sometimes added to this, but it does not suit all cases, and really is not an urgent necessity in the prescription, for the bottle containing the lotion can be shaken vigorously before each application. Recently the chloride of adrenalin has been recommended as a remedy for rosacea. It is administered internally and applied locally, but in the writer's experience it only produced temporary improvement in cases which subsequently rapidly improved under the treatment already recommended.

Diseases of the Sebaceous Glands.—The sebaceous glands vary in size in different parts of the body. They are specially large upon the face, and in this situation their mouths are occasionally inhabited by a parasite, the acarus folliculorum—a parasite entirely harmless, though at one time it was looked upon as the probable cause of acne vulgaris. Abscesses occasionally occur in the glands, which, however, soon extend beyond their confines, and spread into the tissues around. They may be occasionally the starting-point of new growths, and the similarity in structure between them and certain rodent cancers has misled many observers to the conclusion that that disease is a carcinoma of the sebaceous glands.

The disease known as *adenoma sebaceum* is certainly not in every instance correctly named. It is a disease which occurs in children whose mental development is restricted. There is often a history of fits in infancy, and there are some who have suggested that the disease may possibly be in some way produced by the bromide of potassium usually administered in such cases.

The disease consists in the development of a number of papules varying in size, spread all over the face, but particularly in its central division. They also occur upon the trunk, where they are not infrequently associated with small fibrous tumours. In many cases the growths are of the type of lymphangioma, in others they are fibrous, and it would seem that their frequent occurrence upon the face, where the sebaceous glands are normally large, has been overlooked in the estimation of the size of these structures found in the sections of the lesions.

The only successful treatment is by destruction of the nodules, either individually by electrolysis, or by ironing the affected region with the thermo-cautery, so as to destroy them wholesale.

Tuberculosis of Skin

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Lupus.—Clinical Features. — The tubercle bacillus may reach the skin by more than one route, and according to this and the reaction of the patient to the germ, the appearances produced vary.

Lupus vulgaris may be looked upon as the typical tuberculosis of the skin. It is by far the most common, and it is the chief in importance and gravity.

It presents many clinical varieties, all having in common the presence of the tubercle bacillus, along with those pathological changes which we are familiar with as characteristic of the reaction of the tissues to that organism, and differing according to various complicating and secondary changes.

The simplest and the most typical form of Lupus vulgaris is that where there are found in the skin those elements which are described as the "*apple-jelly*" or "*barley-sugar*" nodules of Hutchinson. These are yellowish-brown areas about the size of a hemp-seed; they may be found discrete, or they may run together to form irregular areas. They are evidently *in* the skin. and the epidermis runs unbroken over

them. Their true colour is best displayed by pressing on them a piece of glass, such as the condensing lens of a Hartnack's microscope, for the pressure dispels any complicating hyperæmia, and no amount of pressure will cause the typical nodule to disappear. This method, which Unna calls the "diascopic," is of great value in the diagnosis of a doubtful case.

When examined microscopically, these nodules are found to consist of a collection of those cells which Unna calls plasma cells, and which are best known in Great Britain as epithelioid. These are aggregated into little round areas, ten or a dozen of which go to make up a clinically visible "*apple-jelly*" nodule. Occasionally a giant cell may be observed among them, and very occasionally a tubercle bacillus.

At this stage, which may conveniently be styled Lupus vulgaris simplex, the disease may remain in cleanly, healthy persons for an indefinite period, giving rise to no inconvenience except from its appearance, and spreading very slowly or not at all. Any part of the body may be affected, though, as afterwards referred to, lupus has its preferences and favourite seats.

The disease, however, only exceptionally follows this simple type. The most common complication—so common as to be to most the typical form of lupus—is that of *catarrh*. Just as in catarrhal tuberculosis of the lung, the catarrh is due to the addition to the original disease of other organisms, so in the skin, micrococci are responsible for the change which converts a mere disfigurement into a disagreeable, discharging eruption. The brownish-yellow nodules become concealed by dirty yellowish-black crusts, and pus constantly exudes from the apparently raw surface. This stage of the disease has long been known and described as *Lupus exulcerans*, but the term is a misnomer. There is no ulceration in the true sense of the word. However ulcer-like the case may appear, careful examination will disclose the fact that the surface is still covered, imperfectly it is true, with epithelium. The epithelium is swollen, distorted almost beyond recognition, but it is still there. The process is essentially one of catarrh. In sections appropriately stained there are found on the surface myriads of cocci, and to the effects of these are due the purulent discharge and crusting. The true skin is packed with innumerable leucocytes, which in the majority of cases make it difficult to recognise the tuberculous nature of the disease. It is, indeed, often enough difficult in the leucocyte-impregnated tissues to recognise the same process as in the simple variety of the disease; but a few weeks' appropriate treatment, and the apparent discrepancy is cleared up—destroy the pyococci and the catarrh disappears, leaving the simple variety of the disease.

Another common variety of lupus, which also has its analogy in the lung, is *fibroid* lupus, often erroneously called Lupus verrucosus. The error is curious and inexplicable, because there is a Lupus verrucosus which is distinctly "warty" in its character, though it is much rarer than the fibroid form. Fibroid lupus is most frequently seen on the limbs and buttocks; it is exceptional on the face. In it there is an excessive production of fibrous tissue, and the tuberculous nodules are few in number, but show evidence of their chronicity in the presence of (for lupus) an excessive number of giant cells. There is also some increased activity of the epithelium, but no true warty formation. The prognosis of this form is exceptionally good.

True *warty lupus*, *Lupus verrucosus*, is probably due to the addition to the lupus of the cause, whatever it may be, which produces warts. It occurs especially on the hands and on the buttocks. The same growth of epithelium is seen as in warts, with long processes of connective tissue-forming cores for the epidermic cylinders. As a rule the warty growth and the lupus are coextensive, but in some cases the warts last longer than the tuberculosis.

Verucca necrogenica, or the *post-mortem wart*, is that form of tuberculosis of the skin which appears on the hands of butchers and pathologists, and it would seem a matter which will require a good deal of explaining away if Koch's new theory is to be accepted. It is the most benign form of tuberculosis, and indicates the vigorous reaction of healthy tissues to repeated inoculation with the bacilli. A great part of the growth is epithelial, as, indeed, the name wart suggests. It is commonly situated at the side of the nail, and may persist for years, undergoing very little alteration.

The treatment is that of the warty form of lupus, but if a complete cure is to be attained, the work which caused the lesion must be for a time abandoned.

Lupus is most common on the face, and in a great number of instances it begins on the mucous membrane of the nose or the lachrymal canal, and lasts there unsuspected for, it may be, months before it reaches the skin. Perhaps the next commonest seat is the buttocks, and then come the hands and feet. No part of the body is, however, exempt, unless it be the scalp, where primary lupus is almost unknown, though the disease in rare instances spreads from neighbouring affected areas. It is believed that in some instances flies are responsible for the inoculation of the disease.

Diagnosis.—This is usually easy. Almost always at some part of the disease the presence of apple-jelly nodules can be detected, and the diagnosis is never absolutely certain until these have been recognised. Not infrequently, however, they are obscured by some of the complicating processes. The catarrhal process very rarely entirely conceals them, for the borders are usually not so much affected as the centre

by the catarrh. But in the warty and in the fibroid forms of the disease they are often exceedingly difficult to recognise. In all cases the use of the diascopic method is to be strongly recommended.

In addition to direct observation, a good deal of useful information can be got from the history. It is not likely that a patch of eczema, or, indeed, of any other inflammation of the skin than a tuberculous one, would last for eight or nine years, as these cases frequently do, and suspicions of a tuberculous nature being aroused, careful examination will usually lead to their confirmation. The greatest difficulty in connection with diagnosis is when a chronic ulcer occurs on the face of a patient of middle age. There are two diseases which under the circumstances may be confused with tuberculosis. These are syphilis and rodent ulcer. There are certain differences between each, but these differences must be estimated as a whole and together; too much stress must not be laid on one. Tuberculosis is most apt to commence in youth, syphilis and rodent ulcer toward middle age. The rate of progress is slow in tuberculosis, rapid in syphilis, and slow again in rodent. There is nothing very characteristic in the syphilitic ulcer, but the apple-jelly nodule of lupus and the pearly edge of rodent ulcer are each almost pathognomonic. Rodent ulcer is nearly always single, tubercle in this situation very often so; if carefully sought for, some other sign of syphilis will be found elsewhere. If dependence is to be placed on the effects of treatment as a means of diagnosis between syphilis and tuberculosis, the trial must be a thorough one, and judgment must not be entered on the results of one bottle of iodide of potassium mixture.

There is one routine examination which should never be omitted. No case of lupus of the face should ever be allowed to go with the mucous membrane of the nose and the gums unexamined. The proportion of cases in which the gum is affected is enormous, and the proportion of cases in which its occurrence is overlooked, lamentable. Lupus of the mucous membrane naturally looks different from the disease in the skin, on account, first, of the redness of the surrounding tissue, and, second, of the moist condition in which it is constantly kept. The nodules are usually a little elevated over the surface, and the whole area has an embossed appearance like shagreen leather. The disease in this situation often gives rise to little inconvenience, and patients are often unaware of its existence.

Prognosis.—This is by no means easy. Cases which are left to nature usually occur in the lower classes, where the added disadvantages of insufficient care, food, etc., must be taken into account. If a simple case of lupus were left to itself, and the parts kept clean, and if the patient happened to be in good circumstances, the natural course would be for the disease to extend very slowly though steadily. Any disturbance of health would always involve the risk of catarrhal complications, with increased disfigurement and more rapid extension of the disease. On the other hand, cases are sometimes immensely improved by a simple change of residence to a more healthy locality, where the patient, usually a child, has the opportunity of being much in the fresh air. Indeed, it is unnecessary to waste words on this question. The prognosis of lupus is exactly the same as that of tuberculosis generally. When it is catarrhal, progress will be rapid; when it is fibroid, advance is slow. When treatment is taken into account in the prognosis, we are still by no means certain of our ground. In the first place, all the various factors, such as the health of the patient, the surroundings, etc., have to be taken into consideration. When that is done, we can consider the bearing of the treatment directly and alone; and it must be most clearly understood by the patient that if he desires to get completely rid of his disease, which is quite possible for him to do, he must submit himself to a prolonged course of treatment, that patience must be wanting neither on his side nor on that of his physician, and that a certain amount of irksome detail must be attended to for years. The perfunctory surgical treatment of lupus, scraping a case and then not seeing it again for six months, has no prognosis, but if the case be carefully attended to after such an operation the chances are by no means bad. The fibroid variety of the disease has the best prognosis, cases on the limbs often recovering without any treatment while the catarrhal form has the worst.

Treatment. — One object of dwelling so definitely on the varieties of the disease, and pointing out the essential differences of one from the other, was to make it clear that the treatment of all is not alike. Obviously the same treatment is not applicable to a case scabbed and discharging, as to a hard, fibroid patch. The aim of treatment is to reduce the complicated to the simple form, to get rid of the complications, and then to treat the disease directly. This involves separate consideration of the different varieties. After they have been dealt with, the treatment of lupus as a whole will be considered.

Catarrhal Lupus.—This, as the commonest form of the disease, may be taken first. As has already been pointed out, this catarrh is due to the presence of micro-organisms and their products, and these must be got rid of. Though there are many methods, the simplest and most efficacious is the sharp spoon. It removes diseased tissues and organisms *en masse*, and will do in ten minutes what less active treatment will take weeks to accomplish.

In using the sharp spoon in this way it is not necessary to use much force. The catarrhal tissues are exceedingly soft and rotten, and can be removed with the greatest of ease. At the edge of the patch the spoon may be used a little more vigorously, but at this stage one cannot really hope to eradicate the disease by any amount of scraping.

If for any reason the patient objects to the operative treatment, a similar result may be achieved, though much more slowly, by the application of antiseptics. Brooke's ointment—

℞	Zinci oxidi	
	Pulv. amyli. . . .	āā ℥ij.
	Vaselini albi . . .	℥ss.
	Hydrarg. oleat (5 per cent)	℥j.
	Ac. salicyl. . . .	grs. xx.
	Ichthyol . . .	♏xx.
	Ol. lavendulæ . . .	q.s.

enjoys a wide reputation in this connection, but any antiseptic constantly applied will produce almost as good results. So, too, will another method of treatment, popular in certain quarters, namely, the administration of thyroid substance.

Fibroid Lupus.—Here the complication is the excessive growth of fibrous tissue, which must be got rid of before it is possible to attack the lupus directly. Scraping is useless. No surgeon with any ordinary instrument is vigorous enough to scrape away the tough fibrous tissue. The best method by which it can be dissipated is counter-irritation. Probably blistering fluid is as suitable an application as any other, but carbolic acid, the acid nitrate of mercury, and many other caustics may be used. The reaction often does more than dissipate the fibrous thickening, for a large amount of the disease proper is also removed, and what is left is now open to direct treatment.

Warty Lupus.—In this, as already indicated, the warts are rather to be looked upon as an addition than as a complication. They are best removed by the knife or scissors, although they may also be removed by various applications, such as acetic or salicylic acid. If they are present over a large surface, the best treatment is to level the part with a razor.

Lupus Vulgaris Simplex.—In dealing with the simple form of the disease (whether it has always been simple or has been reduced to this from another form) our aim is the destruction of the tubercle bacillus. The first method of treatment which may be considered is that of excision. Theoretically, excision is the best method, but, unfortunately, the practical application does not coincide with the theory. Lang, of Vienna, apparently treats all his cases, however severe or extensive, by this method, but he seems to attain a degree of success which is not even distantly approached by any other operator. Cases are often made worse by excision, the disease returning in the scars or grafts, often apparently with redoubled activity. The only form of the disease in which excision seems justifiable is the fibroid form, and in that the prognosis is so generally good that, unless in special circumstances, it is rarely necessary. If excision is to be done, it *must be thorough.* The line must extend well beyond the external evidence of the disease, and the entire thickness of skin must be removed from the part. If it occurs on the face, the fact that the hair follicles often extend very deeply must be borne in mind.

The next method of treatment may be described as the directly destructive method. In this we apply to the skin drugs which have what is called a selective action, because they act very much more vigorously on the weakened, diseased lupus tissue than on the healthy surroundings. Of these the most demonstrative is arsenious acid. This is made into a paste—

℞	Acidi arseniosi . .	grs. x.
	Cinnabar . . .	℥ss.
	Ung. rosæ . . .	℥ss.

and applied night and morning for three days. The pain is excessive, and it is often necessary to administer morphine. The whole region swells up, often to an alarming extent, and at the end of the third day the lupus nodules are seen as little black sloughs, dotted here and there in an intensely hyperæmic, swollen skin. Under soothing remedies this swelling goes down, and so much of the disease is removed. Nicholson recommends a paste of equal parts of arsenious acid, powdered acacia, and orthoform, the latter ingredient almost annulling the pain of the arsenic. The disadvantages of the method are, the pain and swelling which it causes, and the unsightly scars which often result unless very great care is bestowed on the management of the resulting granulating surface. Salicylic acid has a similar action. In no form is it so efficacious as in Unna's salicylic creasote plaster. Ointments with a similar composition are not nearly so satisfactory, and the plasters should always be preferred. They are made in different strengths, and the strongest which the patient can stand should be selected. The 30-40 formula is a fair average one. The plaster should be applied night and morning, and in a few days the lupus nodules stand out in the form of whitish sloughs, which can be wiped away with cotton-wool. Now comes up the question of what is to be the further treatment. Many at this stage apply soothing ointments, as in the arsenical method, but if the patient has the fortitude to persevere in the use of the plaster until healing take place under it, the results are much more thorough, lasting, and satisfactory. Often, however, the pain is so great that he refuses to continue, and some other application must be used. Nothing is

gained by promoting too rapid healing of the ulcers of the skin. Indeed, the longer the part is kept open and discharging, the longer does the benefit seem to last. Dry iodoform or a pretty strong iodoform ointment may be rubbed into the part; probably the iodoform destroys some of the bacilli which still exist. By several courses of this plaster the nodules may be so reduced in number as to be open to individual treatment. They may similarly be reduced in number by another less painful method, viz. the very thorough application of oleate of mercury. The formula recommended by Allan Jamieson is—

℞	Hydrarg. oleat. 5% . .	ʒj.
	Ichthyol . . .	℥xx.
	Acidi salicyl. . . .	grs. xx.

This must be thoroughly rubbed into the part for at least twenty minutes every night, and ten minutes every morning. The results are usually very satisfactory. When by one or other of these means the nodules have been reduced to a manageable number, methods such as the thermo-cautery are applicable. The ordinary Pacquelin point is too broad to be of any benefit at this stage. The point must be so fine as to enable one to pierce the individual nodules, and the best instrument for this purpose is Unna's "microbrenner," in which a copper point is fused on to the end of the platinum. With this any visible nodule is pierced and immediately destroyed. The galvano-cautery is more useful, mainly because the burn is followed by a greater amount of reaction than that of the thermo-cautery, but it is, of course, not always available. Another and a simpler method is the puncture of each nodule by a pointed wooden match dipped in some caustic. The favourite caustic for this purpose is the acid nitrate of mercury, and the simplicity of the method is a strong recommendation. The operation must be repeated and repeated until every single nodule has disappeared, and only then should the patient be released from observation, with orders to report himself at the first sign of recurrence. The fact that this preparation loses its strength when kept must be borne in mind, and the fresh preparation should be used with great caution, for it often produces a serious amount of destruction.

The disease may also be attacked indirectly. Probably the two methods, the direct and indirect, are always more or less combined, though the one usually predominates over the other.

The indirect method aims at setting up such a reactionary hyperæmia in the skin that the tuberculous material is destroyed indirectly. When the disease affects the limbs, the congestive method of Bier may be tried. This consists in applying a ligature so as to produce prolonged congestion of the part, and is in some cases as useful in lupus as it is in tuberculosis of the joints.

More commonly the reaction is produced by the application of some irritant. The action of carbolic acid is almost entirely indirect. The slough produced by its destructive action is so superficial that it notoriously hardly leaves any scar, and therefore its chance of penetrating down to the diseased nodules is very small indeed. It sets up, however, a considerable reaction, and under its application the nodules grow less in number and size. The acid nitrate of mercury may be used in the same way. Kaposi used a solid stick of nitrate of silver, ploughing furrows in every direction through the disease. This method is only available in the catarrhal form of the disease, in which other means of treatment are preferable.

The *Liquor antimonii chloridi* is another valuable application. It does not produce such severe immediate results, but after a few days' application, it being painted on daily, the part generally becomes so tender that it must be intermitted for a few days. There is no better application to entrust to the hands of a patient of only ordinary common sense than the liquor antimonii chloridi, and it has the further advantage that it may be applied to the fibroid form, and thus remove both the complication and the disease at once. Pyrogallol is another useful remedy. It is best used in the form of a ten per cent ointment, which should be continuously applied. It sets up a considerable reaction, but as the effects of that are beneficial, it should not be stopped on that account. It may also be applied in collodion, but the effects are not nearly so satisfactory.

In the selection of any of these methods one must be guided by a variety of considerations. The cosmetic effect is one of the most important. If the disease is on the face of a girl, one is bound to be more considerate of the resulting appearances than in the case of a male. In a working man, vigorous scraping with the sharp spoon may be used. While this often results in somewhat unsightly hypertrophic scars, the rapid removal of the disease is in such cases of most importance. In the case of a girl the spoon should only be used lightly, and be directed to the removal of the diseased products rather than to the removal of the disease itself. Arsenious acid, too, though thorough, is often followed by unsightly scars, and should not be used when appearance has to be considered.

The applications which are followed by the best cosmetic results are salicylic acid, liquor antimonii chloridi, and pyrogallic acid, probably in the order named. If the disease is very extensive, of course the possibility of the absorption of any drug must be considered, as must the painful effects which they each produce. If the patient is very sensitive, probably antimony is as good as any other treatment, different parts being painted in

succession. In the case of children the element of pain must be specially taken into consideration. It is obviously absurd to expect a child to put up with the constant boring pain of salicylic acid and some of the other preparations, and in children, speaking generally, the best application is carbolic acid. The pain is severe for the moment, but rapidly vanishes, and even though it may not be the most suitable application to the form of the disease, the fact that there is a patient behind the disease, as Mr. Morris sagely remarks, must never be forgotten.

Lupus of the mucous membranes is best treated by the application of strong lactic acid, the part being painted daily, or less frequently if the pain experienced is very severe. Improvement is usually obvious and rapid.

Photo-therapy.—The two methods of photo-therapy are not very easily compared with the older methods of treatment. In the first place, they involve an apparatus of considerable expense, and are therefore only likely to be used by those who have a considerable number of cases to treat.

The one which has been most largely used is the X-ray method. The dermatitis set up by exposure to the rays soon became familiar, and it was to this irritative effect that the benefit which resulted was originally ascribed. Experience, however, has shown that, over and above their irritant effects, the rays have a directly curative influence. Often enough under their use, without any evidence of irritation, beyond it may be a greater tendency to scaling, improvement steadily goes on. The catarrhal complications vanish. The skin becomes smooth, and the nodules diminish in number until each one may be identified.

While the rays may be used in any case of lupus, the unaffected parts being protected by lead-foil, they are of special value in widespread cases, for their effects reach far beyond the area of skin directly exposed to them. In circumscribed patches, where the healthy surrounding parts are covered with lead-foil, no great harm is done if irritation is produced, and such cases may be exposed for five minutes daily until the case is cured. If the reaction is excessive, then an interval of rest is desirable. In widespread cases, such as those affecting the whole face, greater caution is essential. The patient should be exposed, once only, for ten minutes to the rays, and several days should then be allowed to elapse so as to gauge the susceptibility of the individual. If there is no reaction, then daily exposures may be commenced. If there is reaction, then the intervals between the exposures must be lengthened, and the time of exposure shortened.

In extensive cases affecting half or the whole of the face, no method of treatment can approach the X-rays in their efficiency.

The other (Finsen's) method of treatment, the application of concentrated light, is more tedious, and was until recently enormously more expensive—so expensive as to place it beyond the reach of any but wealthy hospitals. Recently, many new and practical modifications of the method have been introduced, and now a working Finsen apparatus can be procured at a cost less than that of a good coil. It consists of a small arc lamp surrounded by a water-jacket. The apparatus is very rigidly mounted, and the patient leans heavily against the lens, through which are focussed the rays on the part which it is intended to treat. The object of this pressure is to dispel the hyperæmia of the part, for the rays only penetrate red with difficulty.

With this modified apparatus exposures of a quarter of an hour's duration produce a reaction over an area four times the size in a quarter of the time requisite in Finsen's original apparatus, in which the lenses were very small. On the next day a blister appears upon the surface, which may be dressed with any simple ointment, and allowed to heal up while other parts are being attacked. In this way the whole affected surface is gone over, over and over again, from five to eight times circuits being usually necessary to complete a cure.

Both these methods are followed by extremely satisfactory scars—scars infinitely superior to those produced by any other method of treatment.

Their use does not prevent the simultaneous application of other remedies, and particularly, when the nodules are greatly reduced in number, they may be individually destroyed more easily and more rapidly by some of the simpler methods already referred to.

Internal Treatment.—There is no specific for lupus any more than for tuberculosis in general. The only medicine which seems to have any effect on the disease is cod-liver oil, which, by improving the general condition of the patient, enables him more successfully to combat the ravages of the bacillus. Thyroid has already been alluded to. It certainly dissipates the catarrhal products, but has little further influence. Creasote, arsenic, chloride of calcium, and other drugs which have been at one time or another recommended in the disease have but little influence.

There are one or two other forms of tuberculosis of the skin which are not included under "Lupus."

Scrofuloderma is the term used to describe those cases of tuberculosis of the skin where the infection proceeds from a tuberculous focus beneath. Thus it is most common over broken-down tuberculous glands, and in the neighbourhood of fistulæ from tuberculous bones. The appearances are familiar enough. The reddened skin, often with a bluish tinge, the thin

ragged edges, the comparatively scanty discharge, and the tendency to fibroid thickening in the neighbourhood, coupled with the chronic course of the disease, make up a picture which is easily enough recognised. The infection of the skin being secondary, this disease is usually of secondary importance. The underlying disease is the essential element, and on its cure depends the progress of the skin malady. Sometimes the infection develops into true lupus, which may persist after the underlying disease has disappeared, but as a rule the cure of the one is associated with the cure of the other.

Treatment.—This really belongs to the surgeon. The case should be taken in hand by him long before there is any risk of infection of the skin, and with the improved modern methods of dealing with tuberculous glands the disfiguring scrofulodermata of the neck are gradually becoming less and less frequent. When the disease has infected the skin, and the focus beneath is comparatively small, a thorough scraping will in many cases successfully eradicate the disease. Scraping in scrofuloderma is followed by a success which does not follow it in the treatment of lupus. But it is well to recall once more what has already been said, that these cases are in the province of the surgeon, and if the medical attendant is not prepared to take them thoroughly in hand and treat them radically, he ought to hand them over to some one who is.

The other forms of tuberculosis are rarer, and hide their identity and nature under other names.

Erythema induratum scrofulosorum, or Bazin's disease, is an affection which occurs most frequently in girls and young women whose occupation involves a great deal of standing. It attacks the legs only, usually the lower part of the calf, posteriorly. One or more nodules develop below the skin, which takes on a livid bluish colour. The nodule increases in size, and ultimately its centre breaks down; a slough separates, and the clinical resemblance to a syphilitic gumma becomes very close. An erroneous diagnosis is made. The patient is put to bed. Large doses of iodide of potassium are administered, and the patient has the advantage of rest and the hospital diet. When recovery takes place, the credit is attributed to the accuracy of the diagnosis and the suitability of the treatment prescribed; nevertheless, the patients do equally well if the iodide of potassium is omitted.

Etiology.—Some observers are sceptical of the tuberculous nature of this malady, but bacilli have more than once been found; inoculation experiments have several times been successful; the architecture of the growths is that of tuberculosis, and the positive evidence far outweighs the negative.

According to Whitfield, two conditions are confused under this name—one a tuberculosis, and the other a condition of vascular origin. This latter form occurs, he says, in later life, and is associated with phlebitis and some endothelial proliferation. This second group of cases is very much more amenable to treatment, and often a week's rest is sufficient to clear up all the lesions.

Diagnosis.—The seat of the disease, the age of the patient, the history of prolonged standing, and the peculiar livid-blue colour of the early lesions make the diagnosis comparatively easy. The only condition with which it can be confused is the syphilitic gumma, and tertiary symptoms in young girls are at least very exceptional. Erythema nodosum, which is also common in young girls, develops much more rapidly; the lesions are both painful and tender, they are generally more numerous, and are situated on the front of the leg, whereas those of erythema induratum occur on the back and sides.

Prognosis.—This is favourable; rest, etc., as described under treatment, almost always resulting in comparatively rapid recovery.

Treatment consists in rest in bed, elevation of the limb, generous diet, and the administration of cod-liver oil. The healing of the ulcers is often promoted by strapping of the part.

Lichen Scrofulosorum.—This is an eruption which appears on the trunk of children who are suffering, or will suffer, from some form of tuberculosis. Most commonly it occurs in those who have either bone or lung disease; and in using the expression "will have," one of course labours under the difficulty that the recognition of the skin disease directs attention to the possibility, and leads to the sometimes successful treatment, of a tuberculosis which may not be otherwise recognisable. In this respect a knowledge of the disease is important, as it may be the first warning of the presence of tuberculosis.

The eruption is usually on the trunk, although in exceptional cases it may spread to the limbs and face. The forms it assumes vary. Some of the papules very closely resemble lichen in their shape, and have the burnished top which is associated with that disease; but this is merely due to mechanical causes, and the papules have not the lilac colour of that disease. Others of them are pustular, while others, again, are covered with a tiny crust. Their distribution is irregular; but they show a tendency to group themselves in circles, and segments of such. This is merely due to the accident of a number of pustules being situated in the hair-follicles, whose natural arrangement they naturally follow. The lesions are, however, by no means restricted to the follicles, and for this reason the term of *Folliculitis scrofulosorum*, suggested by Unna, is probably no great improvement on the one which at present is in use.

Diagnosis.—The occurrence in children, the unusual nature of the rash, in which papules and pustules are arranged in circles, and segments of these, and the presence of some other evidence of tuberculosis, usually make this easy.

Treatment.—No treatment is so successful as that originally introduced by Hebra, which consists in the internal administration and the external application of cod-liver oil.

Skin Diseases of the Tropics

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Introductory.—To attempt a full description of tropical cutaneous diseases would be quite outside the scope of this article, since it would necessitate reference to almost all morbid skin conditions.

Many pandemic diseases, such as Scabies or the Syphilides, are hardly affected by tropical conditions, except perhaps in the direction of increased severity.

Contrasting with these are some in which such conditions either have a decided influence in causation, as in Furunculosis, or impress, as in Ringworm, distinct features upon the disease.

Yet another class is limited in distribution, as far as is yet known, to warm climates, and apparently altogether depends for development upon their climatic or other peculiarities. To this last group therefore, and to any peculiarities in the second resulting from change of climate, attention in this article will mainly be directed.

Physiology of the Skin in Warm Climates.—The general physiological effect of tropical heat is to withdraw the blood from the centres of circulation to its periphery. The amount of increase varies, of course, with the degree of heat, the fluid ingested, the exercise taken, and inversely with the degree of humidity; but Rattray calculates that the skin circulation is increased by 33·27 per cent, balancing the reduction in that of lung and kidney.

The Negro, with his copiously secreting sweat and sebaceous glands, appears to have accomplished this adjustment of the circulation, and the chilliness and polyuria generally experienced by the European on leaving the tropics, and his increasing habit of perspiration when long resident there, suggest that with him also it occurs to some extent.

The hyperæmia and increased functional activity, with the profuse secretion induced, must therefore be expected to predispose in his case to cutaneous disease, or aggravate that already existing, just as in the negro this circulatory alteration appears to predispose to pneumonia in cold weather. Not infrequently, however, some chronic complaints, for instance certain forms of eczema, derive benefit from a change to the tropics. The amount of sensible perspiration naturally varies with the degree of humidity, a fact of some significance, for it is during rainy seasons and in humid climates, where the clothing is constantly saturated, that Prickly Heat chiefly occurs, and that the epiphytic and ectozoic skin diseases find especially favourable influences for development.

The chief conditions, then, which influence the prevalence and impress peculiarities upon cutaneous diseases in warm climates may be summed up as follows:—

(1) Purely climatic conditions, such as solar heat, high temperature, and humidity.

(2) Personal Conditions.—The entry of organisms is favoured by difficulties attending cleanliness of person and clothing where perspiration is constant and excessive, by faulty personal hygiene among natives, which reacts upon neighbouring Europeans, and by the prevalence of small abrasions from insect bites or scratching. When once entered, the debility and malnutrition, so frequently the result of climate and disease, materially aid their development.

(3) Environmental Conditions.—The distribution of the Chigger itself and of the intermediate hosts of Filariæ determines the occurrence of disease associated with these parasites, while inefficiently supervised water-supplies, and the careless habits of natives with regard to washing, are largely responsible for the spread of these and allied ailments. With

Europeans the occurrence of boils and prickly heat is aided by their habits as regards diet and alcohol.

The flies, mosquitoes, or other insects so numerous in the tropics also play an active part in the causation of skin disease, either by depositing larvæ (mycosis), by merely acting as passive carriers of infection, as in yaws possibly, by actually introducing germs or parasites in their bites, or, indirectly, by carrying infection into drinking-water.

(4) Racial Proclivities.—The negro, either from greater skin pigmentation and production of oily secretion, or more probably from differences in clothing, is far less liable to prickly heat than either white or brown races, but on the other hand he is, in addition to an unexplained tendency to keloid, infinitely more likely to be attacked by germ or parasitic diseases. The explanation of the European's comparative immunity to these probably lies in the protective influence of clothing and foot covering, his greater attention to small abrasions, and avoidance of dirty houses and clothes, and of diseased persons.

(5) Lastly, there are certain unknown endemic conditions which determine the occurrence of verruga and oriental sore.

General Care of the Skin.—The diet should be adapted to the climate. Less albumen and fatty matter being necessary, fruit and vegetables should be largely substituted, and liquids, especially alcohol or hot drinks, restricted as far as possible, and the water-supply supervised. Woollen or cellular clothing is best in humid atmospheres, and like that of the native should be loose fitting, light in colour and texture, and free from tight bands, thus permitting proper air circulation. Frequent changes of clean underclothing, and especially the use of short drawers washed by some trustworthy person, help to prevent Dhobie Itch. It is also necessary to protect the lower extremities from contact with mud and water. Frequent bathing should be indulged in, but soap little used.

Mosquito and insect bites should be avoided as far as possible by means of nets, but even slight abrasions must be carefully attended to. For opposing skin surfaces, dusting powders of starch and zinc oxide are useful, and general inunction of lanoline or other preparation is a useful preventative of Prickly Heat where there is a tendency to this complaint.

I. Caused by Climatic Conditions

(*a*) Prickly Heat.—*Synonyms:* Lichen Tropicus, Miliaria Papulosa.—Nearly all Europeans in hot, damp climates suffer from this affection. The eruption usually develops suddenly, closely following or coincident with a profuse perspiration, and consists of numerous hyperæmic-looking, pointed papules intermingled with a few minute, shining vesicles containing clear fluid. Once developed, anything which excites perspiration, and especially hot tea or exercise, will at once increase the characteristic prickling, tingling, and burning sensations, while the irritability of the skin is accentuated by scratching and by the friction of soaked clothing.

Almost the entire cutaneous surface, except the palms and soles, may be involved, but the site of election is where the clothing is in contact with the body, around the waist, or on the back, trunk, or extensor surface of the forearms. With varying severity the eruption may persist for almost any time, but speedy improvement usually follows falling temperature or lessened humidity. Though not in itself dangerous, the resulting irritation and insomnia may complicate disease or in delicate persons even in itself prove injurious, while organisms introduced by scratching or wet clothing are a fertile source of subsequent Furunculosis.

Pathology.—Pollitzer found cyst-like spaces in rete mucosum which he regarded as dilated sweat ducts produced by the occlusion of their orifices by the swelling of the horny layer from soaking in perspiration. Pollitzer found no evidence of inflammation or of alteration of the coil glands; but Török, as the result of his investigations, regards the vesicles as inflammatory in origin. From the occurrence of the eruption only where there are sebaceous glands, Pearse, on the other hand, inclines to regard it as an acute seborrhœa, the result of irritating secretion and over-production by these glands. It seems, however, more reasonable to suppose that the washing away of sebum by the copious watery secretion prevents it from efficiently performing its function of oiling the skin, and therefore allows the swelling of the horny layer. The thickness of the latter, and the natural absence of sebaceous secretion in palms and soles, explains their immunity from eruption. Although irritation possibly plays a part in production, the other view is borne out by the special prevalence of Prickly Heat in humid climates and during the rainy season, where evaporation is hindered, and by its preference for parts in contact with clothing, where sweat collects. It occurs, too, on the backs of prostrate invalids in the tropics, and the writer has frequently seen recurrences in old tropical residents during an English summer, confined to the region beneath the abdominal belt. Similarly, Europeans are the chief sufferers, while negroes are almost immune, partly perhaps from their naturally oily skin, but largely from the paucity and looseness of their clothing and from their habit of anointing themselves with oil.

Treatment.—Perspiration should be reduced by the utmost possible avoidance of exertion and of liquids, and by occasional saline purgatives. The clothing, light both in colour and texture, should consist of woollen, cellular, or

silken material which will absorb much moisture and thus permit evaporation. To make it loose and airy, braces and belts should be avoided and combination garments worn, while the position should be changed and grass mats, or "dutch wives,"[1] used for the bed, with the same object of avoiding prolonged contact with the clothing. The latter should be frequently changed. No soap should be used in the bath, as it removes the sebaceous secretion, but inunction with some oily material after the bath, such as almond oil and lanoline—8 of oil to 1 of lanoline—with menthol to allay irritation (Pearse), or cocoa-nut oil (Moores), should be substituted, as it helps to prevent the swelling of the horny layers. Menthol, carbolic acid, or calamine lotions will temporarily allay irritation.

(*b*) Intertrigo.—A certain degree of this almost invariably occurs in the tropics from heat and moisture combined with chafing. On board ship, possibly from salt-water bathing, it is particularly prevalent. It is raw and painful as well as itching, and if irritated may proceed to vesicle formation or even pustulation, while, as with ringworm, recurrences on return of exciting causes are very common. The usual site is the crutch, and the ailment is chiefly important as providing a favourable opportunity for the attacks of tropical ringworm or similar disease.

Treatment.—Careful toilet of the skin is the best preventative. If developed, rest, separation of the opposing surfaces, and dusting with some soothing antiseptic powder usually suffices for the time.

(*c*) Leucodermia and Keloid.—Although the exact pathology of these two diseases is at present unknown, the extreme liability of many natives of warm countries to disease of the pigmentary system of the skin, such as leuco-dermia and albinism, and of black- and yellow-skinned races to keloid, seems to point to climatic influences as factors in their causation, and they are therefore mentioned here.

II. Constitutional Infective Diseases with marked Skin Lesions

Some of the exanthemata, and in particular scarlatina, do not flourish in tropical countries, but, on the other hand, chickenpox and smallpox are infinitely more common. The absence of vaccination probably accounts for the latter. In addition to these, however, there are three constitutional diseases — leprosy, yaws, and verruga—which are prevalent in the tropics and which more particularly affect the skin. These are elsewhere described. Shima mushi, the river fever of Japan, might also perhaps be mentioned here, although it is not communicable.

[1] These are hollow cylinders of open rattan work, used in tropics.

III. Skin Diseases probably or certainly caused by Bacteria

(*a*) Boils.—Although universally distributed, this troublesome affection is particularly common in the tropics, and in hot, moist climates few escape. The sodden state of the skin and clothing, the numerous minute lesions resulting from insect bites and prickly heat, the debilitating effect of excessive heat and poverty of diet, provide conditions eminently favourable to the presence, entry, and development of the responsible organisms. They are especially prevalent on board ships after long spells of ship's food and distilled water, and among men rather than officers, probably because these conditions are then aided by salt-water bathing and less care about underclothing. Moist weather increases their prevalence, while defective diet undoubtedly predisposes, and largely from this latter cause more than half the crew of the writer's ship suffered on one occasion, although the infection was doubtless conveyed from one to another.

Treatment.—Fresh diet, vegetables, attention to general health, cleanliness, and care of the skin form the most useful prophylactic measures. Calcium sulphide and other drugs have been recommended. When the disease has developed, removal of the constitutional condition which has favoured development of the bacterial cause is perhaps even more indicated in the tropics than elsewhere. With this object, purgatives and cholagogues are often valuable, but fresh meat, vegetables, or lime juice are even more necessary. Calcium sulphide in quarter-grain doses every two hours is recommended by some, yeast by others, but with anæmia at all evident port wine or iron and quinine tonics are probably more useful.

Local Treatment. — Salicylic acid plaster application, or boring into the centre with a pointed wooden match charged with pure carbolic acid (Manson), will often abort a commencing boil. With general furunculosis frequent antiseptic baths are of value. In advanced stages soothing and protection, with prevention of auto-inoculation by absorption of discharge, are the chief desiderata, and Bulkeley's method of treatment answers admirably. The centre of a square of absorbent cotton is coated with the following ointment: ℞ Acidi carbolici, gr. 10; ext. ergotæ liq. ʒi; pulv. amyli, zinci oxidi, āā ʒii; unguent simpl. ℥i, and fixed over the boil by strips of plaster so applied as to leave the centre free from pressure. Incision is valuable in boils of scalp and axilla.

Boils of External Ear.—Although a common enough affection at home, this is infinitely more prevalent in damp tropical regions like West Africa or the West Indies. No doubt their occurrence is favoured by constitutional

deterioration and the suitable local conditions, while their prevalence in ships again suggests salt water as an etiological factor.

Symptoms.—Pain, tenderness, and localised swelling are the prominent features, but the condition must be distinguished from the diffuse inflammation sometimes complicating otomycosis.

Treatment.—Cleanliness, careful drying of the ear, and avoidance of salt water constitute the best means of prophylaxis with boils as with otomycosis. The most satisfactory treatment of the developed boil is early incision, followed by instillation of some antiseptic to prevent the production of others by auto-inoculation. A very good anodyne and antiseptic is as follows:—℞ Carbolic acid, cocaine, āā gr. 10; glycerine, ʒii. Instil a few drops.

(*b*) Furunculus Orientalis.—*See* vol. iii.

(*c*) Veldt or Natal Sores.—Although hardly a tropical ailment, this seems a suitable opportunity for mentioning a form of ulcer to some extent allied to furunculus orientalis, but apparently peculiar to South Africa, and frequently encountered during the recent campaign. One or more, rarely exceeding the size of a shilling, may be present, and generally involve the exposed portions of the body. The sore usually commences as a blister with serous contents and with ill-defined margins, fading gradually into healthy skin. When this bursts it leaves a red, irritable-looking ulcer, surrounded by a halo of redness, and which involves the true skin and extends marginally. The discharge is either serous or purulent, and sometimes forms crusts over it. Lymphangitis is an occasional complication.

Etiology.—There is little doubt that the entry of some organism, probably inhabiting the soil, determines the occurrence of these sores, and Ogston has found a micrococcus resembling the gonococcus in large numbers in the fluid. Mounted men have been said by some to be specially liable, and ticks or horse flies may possibly influence causation by producing cutaneous lesions or by carrying infection. The sores occur all the year round. Natives of the country appear to be immune.

Treatment.—Ogston recommends cutting away the dead skin around, and the application of some good antiseptic dressing.

(*d*) Tropical Phagedæna. — *Synonyms.*—Donda Ndugu, Yemen, Cochin China, or Mozambique ulcer. A rapidly spreading, necrotic ulceration of skin and subcutaneous tissue, common in the tropics.

Geographical Distribution.—There is probably hardly a tropical country free from this disease. Especially frequent upon East African and Red Sea shores, and in Cochin China, Cayenne, and Fernando Po, it is also common in the Western Hemisphere in such parts as the West Indies and Mexico, and occurs in even comparatively temperate climates like Algiers or Egypt.

Etiology.—The disease chiefly attacks those debilitated by climate, enfeebling disease, starvation, over-exertion, or unhealthy surroundings. For this reason, badly fed and feeble natives subject to exposure are the principal sufferers, and for long it has been the scourge of exploring expeditions and of slave-gangs. It is principally found in low, damp jungle lands with hot, debilitating climates, such as sea-coasts and shores of rivers and swamps, and is less common in dry, elevated localities.

Doubtless some micro-organism is the essential cause, and Le Dantec has found in the exudation swarms of non-motile bacilli, straight or curved, and 7μ to 12μ in length. He has not, however, succeeded in either finding them in the blood, cultivating them, or obtaining any positive results from inoculation. He believes that the organism is contained in damp soil, and is carried by flies, but his investigations are incomplete. The virus probably effects an entry on all occasions through some abrasion, insect bites, or skin eruption. To some extent the disease resembles hospital gangrene, both etiologically, clinically, and, according to Le Dantec, bacteriologically, but it is far less infectious and tends to self-limitation, while experiments to transmit it have failed.

Symptoms.—Generally, though not always, the legs below the knee are the parts most affected. Where there is no pre-existing wound, the first appearance is usually that of a puffy swelling, giving a boggy, fluctuating sensation, and presenting one or two whitish blebs with sero-sanguineous contents. Although it causes lameness, it is, as a rule, unattended by pain or heat, but there may be a painful reddish marginal zone. The swelling subsequently ruptures and leaves exposed a large, pulpy grey mass of slough, which extends with wonderful rapidity from auto-infection with the discharge, and the surrounding parts become infiltrated with greyish exudation. Not only may this necrotic condition involve skin and subcutaneous tissue, but also muscles, tendons, nerves, vessels, or even periosteum of bones. When the slough is exposed there is a fœtid odour, and pain may be intense and constitutional disturbance of an adynamic type marked.

Pre-existing wounds if attacked become dry, dark-coloured, and rapidly necrotic.

Provided the health is fair, the ravages of the disease may be checked and chronic ulcers result, but with debilitated patients it may make rapid strides and cause death by opening a large vessel or from septic absorption. Usually, however, the process is sooner or later checked, but lifelong deformity not infrequently results from the extreme destruction of tissue.

Treatment.—Prophylaxis resolves itself into the care of the general health, particularly of native camp followers in expeditions, insistence upon proper care of skin lesions, and protection

of the legs by putties or other coverings. Those attacked should be isolated. Where the ulcer is present, the constitutional condition should be treated by nourishing diet, fresh vegetables, lime juice, quinine, and tonics; and opium is generally necessary to relieve pain and give sleep. Locally vigorous treatment is best. The sloughing mass should be removed by the actual cautery, curetting, or by swabbing with pure carbolic (Manson); the surface is then dressed antiseptically, or better, irrigated or placed in a continuous antiseptic bath. Should sloughing again recur, the mass is again removed. When once checked, the treatment is that of ulcer, but splints, strapping, or skin-grafting are often needed to aid cicatrisation.

(*e*) Pemphigus Contagiosus. — *Tobi Hi.*—A contagious skin affection characterised by the formation of vesicles and bullæ and subsequent exfoliation of skin.

Geographical Distribution.—It is met with during the hot season along the southern coast of China, and in Japan and the Straits Settlements, and has also been described in Madras, Queensland, Trinidad, and America. Very possibly it occurs in other hot, damp climates.

Etiology.—Children, especially of European parentage, are chiefly attacked, and particularly favourable opportunities for its spread are provided by schools and similar institutions. Among adults, Europeans occasionally suffer, but natives rarely do. The cause is probably of a bacterial nature, and a diplococcus has been found in the fluid of the blebs by Manson and Munro. The latter observer cultivated it in various media, but failed to reproduce the disease in lower animals. Yokuma has, however, successfully inoculated a patient already infected, and obtained pure cultures from the lesion.

Symptoms.—Minute red hyperæmic spots precede the development of vesicles and bullæ, which rapidly form on their site. Slight itching or burning usually heralds their appearance but then diminishes, although, when they collapse, it may return. The bullæ and vesicles are hemispherical in shape, and in size vary from that of a split pea to that of half a large marble; there is sometimes a slightly marked area of congestion around. Within them is fluid containing leucocytes, the diplococci, and a few cells from the stratum granulosum. This fluid, at first clear, subsequently becomes opaque and the blister flaccid, at which period it usually ruptures, discharging its contents and leaving a weeping red surface under the cuticle, which at times continues to exfoliate round the margin. Rarely, the bullæ may coalesce, thus denuding a large surface. Later, all that is left is a pinkish spot, perhaps covered by a thin scale. The eruption in adults is commonly confined to the crutch and axillæ, where it may occasion much irritation; in children it is spread to any part of the body, from scratching or other methods of inoculation.

Diagnosis.—To some extent the disease resembles impetigo contagiosum, but the lesions involve trunk and limbs rather than face, and the exfoliations around the periphery of the ruptured vesicle are composed of desquamated epithelium and not dried pus.

The absence of constitutional disturbance, of ulceration and scarring, and the non-occurrence of the eruption on mucous membranes, with the occasional larger size of the bullæ, distinguish it from varicella. In adults, the absence of itching festooned margin and of fungus help to differentiate it from tropical ringworm, for which it may be mistaken.

Treatment.—A cure is readily obtained by thorough cleansing with antiseptic lotion such as perchloride of mercury, and subsequent application of soothing antiseptic ointments, compresses, or dusting powders; but its contagious nature must be remembered, and all necessary precautions taken with regard to isolation, clothing, and so on. Tonics, particularly arsenic and quinine, are occasionally indicated.

(*f*) Craw-Craw.—In West Africa this name is given to various itching cutaneous diseases—most commonly, in the writer's experience, tropical ringworm or scabies. O'Neil in 1875 first described as craw-craw a contagious disease resembling scabies, in which he found numerous filaria-like organisms on shaving off the tops of the papules. Later, Nielly saw in an untravelled French lad a similar papulo-vesicular itching eruption with nematode embryos in the blood, in addition to organisms in the papules, and called it Dermatose Parasitaire. Emily has likewise described under the name craw-craw a papulo-pustular affection common in tropical Africa and in India, China, and elsewhere (Manson). An itching papule forms, which as the result of scratching becomes inoculated with pyogenic organisms, and by auto-infection with discharge extends, producing a pustular eczema. Recently, Bennett has analysed 83 cases of so-called craw-craw, 58 of which he found to be tinea circinata. The disease in the remainder was extremely contagious, and after an incubation period of two to four days began as papules, which developed in four or five days into vesicles and pustules; the hands, arms, and thighs were principally affected. The discharge from the vesicles was peculiar, stiffening linen, and producing yellowish crusts, under which pustules formed, and gave rise to pain and irritation. Filaria perstans was present in the blood of 12 of these cases, filaria nocturna in 2. Doubtless they might have been seen in blood from the papules, thus proving the possibility of Manson's suggestion that O'Neil's organisms came from this source. Bennett looks upon the disease as a pustular eczema, and thinks the name craw-craw should be abandoned.

Treatment.—Antiseptic ointments, or better, thorough cleansing with lotions or baths and removal of crusts and discharge, with subsequent dry dressing with boric powder, rapidly effects a cure; but articles of clothing, such as stockings, infected by discharge should be destroyed. The writer found peroxide of hydrogen spray useful in similar cases.

IV. Caused by Animal Parasites

(*a*) The Chigger or Chigœ—Pulex Penetrans—Sand-Flea.—*Geographical Distribution.*—Though originally found only in latitudes 23° N. to 28° S. of the Western Hemisphere, this parasite was introduced into Gaboon about 1872, whence with marvellous rapidity it has invaded all tropical Africa, entered China, and threatens India, where elaborate precautions are being taken to prevent its spread.

Description.—The chigger resembles the common flea in appearance, but is smaller and has a proportionately larger head and broader abdomen. Its colour is reddish-brown. Although not confined to them, its favourite haunts are low plains, and especially sea-shores and the banks of rivers. The filth and debris about native huts and cattle-sheds provide its headquarters, and in the dust of dark corners of these, larvæ and mature insects protect themselves against rain and high temperature, which are injurious to them.

Both male and female suck the blood, but the harmful effects are produced only by the female, which, when impregnated, bores obliquely through the epidermis to the corium, whence she obtains nourishment. Here, by development of the eggs, the abdomen rapidly enlarges at the expense of the second and third segments, while the unchanged posterior segment blocks the opening in the skin. The eggs, if discharged by its rupture, develop into thirteen-ringed larvæ, which become surrounded by a cocoon, pass through a nympha stage, and arrive at maturity after eight or ten days.

Symptoms.—The entrance of the parasite is marked by itching, often unnoticed by recent arrivals, and the small opening can be seen in the centre of an inflammatory swelling, usually either in the sole or great toe, or in the folds of the toes, the parts nearest the ground, although exceptionally they attack the scrotum, hands, or elsewhere. From the condition of their houses and from absence of foot-covering, natives are especially liable. The parasites usually number one or two, but there may be many. By their abdominal swelling considerable irritation is caused, the chigger becomes bathed in pus, and the skin finally gives way and expels it by ulceration. If the abdomen is ruptured during extraction, or pathogenic organisms enter, this may be very severe.

Treatment (*Prophylaxis*).—Houses supposed to be infected should be cleaned and swept, especially during rains, disinfectants used liberally, and sleeping on the ground or walking barefoot avoided.

When the parasite has entered it can be killed by chloroform or turpentine, but the best treatment is enucleation with a clean needle. Natives are most expert operators. If the abdomen is ruptured during extraction, pure carbolic acid should be used.

(*b*) Cutaneous Myiasis.—*See* Myiasis, vol. vi.

(*c*) Pani Ghao—Ground or Water Itch—Sore Feet of Coolies.—Dalgetty describes as epidemic, during the wet months, among coolies in Assam, Sylhet, and other parts of India, a superficial vesicular dermatitis resembling scabies, and a similar disease is reported from Trinidad and British Honduras.

Symptoms.—Burning and itching are followed by the appearance of vesicles, usually first beginning in the clefts of the toes, and spreading over the dorsum and around the outer edge and sole, but also occasionally involving the hands. The vesicles are at first distinct, but possibly coalesce later and form large blebs or proceed to pustulation or even ulceration or sloughing. Complete laming may result from involvement of both feet.

Etiology.—The disease only occurs in tea-gardens after they have been opened for some years, as the ordure deposited by the coolies forms a breeding-place for the acarus found by Dalgetty in these cases. He gives an elaborate description of this parasite and its ova, and thinks that it may be carried by dung beetles. Impaired health predisposes to its attacks.[1]

Treatment.—Evacuation of the pustules, disinfection of the skin, and application of lime and sulphur or coal-tar ointments, or of phenol lotion, will effect a cure. For prevention Dalgetty recommends close-fitting shoes or clogs.

(*d*) Filarial Diseases involving Skin and Connective Tissues.

Filaria Medinensis—Filaria Nocturna—Filaria Volvulus—Filaria Loa. *See* article on Filariasis, vol. iii.

(*e*) Ixodiasis—Ticks.—Walking through long grass in many tropical and subtropical regions not infrequently results in the acquirement of several of these parasites, as the larvæ climb grass or shrubs and await with their front legs outstretched for any passing animal. An attempt at forcible removal from the skin often breaks off the rostrum, and leaves it as a source of irritation until eliminated like a thorn. When gorged with blood the parasite will drop off by itself, but it can be removed at once by touching the ventral surface with a feather dipped in turpentine or petroleum.

Powder of Pyrethrum flowers dusted over a

[1] Recent investigations by Bentley not only throw doubt upon the connection of this acarus with causation, but also suggest that either the larvæ of the ankylostoma or bacteria found in the soil with it are mainly responsible.

bed, and a lighted lamp alongside it, will keep ticks off at night. The recent discoveries as to their rôle as carriers of infection constitute additional reasons for efficient protection from their attacks.

(*f*) Leeches.—Leeches, terrestrial in their habits, occur in abundance in many tropical countries, while they so abound in pools that natives often refuse to enter them. Additional reasons are thereby afforded for efficient protection of feet and legs and for care about wading in these regions, as the attacks of these parasites may result in very considerable loss of blood. Manson saw cases of horse-leech in the nostrils of men as well as animals in Formosa, and a similar infection has been seen in Southern Europe and Northern Africa. Headache, repeated epistaxis, and anæmia were the symptoms produced.

V. Caused by Vegetable Parasites

(*a*) Dhobie Itch.—*Synonyms:* Tropical ringworm, Herpes circinatus, Eczema marginatum, Tinea circinata, Burmese ringworm.—The name dhobie itch is frequently given in hot countries to almost any itching cutaneous eruption in the crutch or axilla. True ringworm, here as elsewhere, is probably due to the presence of tinea trichophyton or microsporon audouini; but not only must it be distinguished from the prevalent erythema intertrigo and from pemphigus contagiosus, which in adults involves these regions, but also from erythrasma. The usually unirritating microsporon minutissimum and also microsporon furfur, stimulated by tropical conditions, may produce patches not unlike true ringworm, which in colder weather become brown, furfuraceous, desquamating surfaces, yielding the characteristic fungus on examination; only to relapse when again exposed to similar influences.

Etiology.—Though often unjustly blamed, the washerman frequently conveys infection to Europeans. For instance, in the writer's ship, off the Gold Coast, where no one landed, all whose clothes were washed ashore were attacked, while no one else suffered.

With natives the opportunities for direct contagion provided by their crowded houses and the proximity of their domestic animals, and for indirect by their inattention to hygiene and careless habits with regard to bathing and to clothing, together with the favourable climatic conditions for the possible growth of the fungus as a saprophyte, no doubt account for their great liability.

Symptoms.—Although scalp ringworm is comparatively less common, no part of the body is exempt, but the crutch and axilla are the regions usually involved. Dull red itching spots of lean ham-colour develop and spread in festoons over scrotum, buttocks, or thighs, forming an irregular patch. As the raised erythematous itching margin extends the centre becomes pale and scurfy, although always liable to again inflame. Hot rainy weather increases the severity of the disease, and it tends to disappear in cold and recur in warm weather. It is more deeply situated than in temperate climates, and from heat, moisture, and irritation is apt to assume a much more irritable aspect, and to be complicated by vesicle formation or even pustulation or ulceration. The fungus is sometimes difficult to find by microscopic examination.

Treatment.—After thorough cleansing of the part, chrysophanic acid gr. 20 to lanoline ʒi. may be rubbed in twice a day. It should not be applied to the face, and should be stopped when erythema appears around the patch, while the staining effects on the clothes must be remembered. Linimentum iodi of double strength (Manson) is useful for natives, and, although painful, also in the writer's experience for Europeans. One or two applications of glacial acetic acid, followed by ice to relieve the pain, tincture of leaves of cassia alata, freshly prepared sulphurous acid or naphthol in alcohol, 1 per cent, may all be substituted.

Prophylaxis. — The use of light cotton drawers, which have been washed by a trustworthy person, and proper attention to the toilet of the skin, are useful prophylactic measures.

(*b*) Tinea Imbricata. — *Synonyms:* Gune, Tokelau or Bowditch Island ringworm, Herpes desquamans, Le Pita.—A scaly affection of the skin produced by a vegetable parasite.

Geographical Distribution. — Europeans are but rarely attacked by this disease, but in many islands of the South Pacific and the Eastern Archipelago a considerable proportion of natives are affected, and it has gradually extended to the Malay Peninsula, Burma, Bengal, and the Philippines and Formosa.

Symptoms.—Experiments performed by Manson showed that if a point be inoculated, a minute brown spot appears there after ten days' incubation. This steadily enlarges, and a few days later the epidermis ruptures in the centre and becomes separated from the corium everywhere except at its outer edge. Once more a brown spot forms in the centre and a similar process occurs, thus forming two rings of scales, one inside the other. Thus the disease extends, and by inoculation of other parts gives rise to fresh centres of growth, and by their coalescence various designs are formed, and the original concentric pattern interfered with. When a patient presents himself, therefore, a large portion, or even the entire cutaneous surface, is often covered by these scaly concentric ally-arranged rings. The scales (about ½ inch in length by ⅛ inch in breadth) are only attached by their peripheral margin, where the profusion of fungus produces a brownish dis-

coloration, which contrasts with the paler colour under the rest of the scale. Severe itching may be experienced, but otherwise there is no discomfort. The eruption avoids the crutch, axillæ, and nails, and usually the hairy scalp, palms, and soles. The most typical patches are found between the shoulders or other parts protected from mechanical irritation.

Etiology.—If, after moistening with liquor potassæ, a scale is examined microscopically, a profusion of fungus, not unlike the ordinary Tricophyton, is found. It differs, however, in its greater abundance, and its chains of spores are oval, rectangular, or irregular rather than globular, and more numerous than the mycelial threads, which, in their turn, are long and straight or gently curved rather than short. Fairly high temperature, moisture, and uncleanly habits favour its growth and spread; but too high temperature, cold, or dryness exert an unfavourable influence. Tribondeau appears to regard it as a lepidophyton. Clinically, the disease is distinguished from ordinary ringworm by the invariable presence and the microscopic features of the fungus, the absence of inflammation, the large scales, the wide surface involved, and its avoidance of the axillæ. In addition, the corium is not invaded, nor the hair-follicles, when the scalp is attacked; the disease does not abandon a part once involved; and, lastly, there are the effects of inoculation.

Treatment.—Any epiphyticide will, from the extent of surface, kill the parasite, but time is required, and the clothes must be burnt or disinfected. Manson recommends the linimentum iodi for natives, but chrysophanic acid or cassia alata leaves are also valuable.

(*c*) Mycetoma.—*See* vol. vi.

(*d*) Otomycosis.—Highet and others have shown that this affection is common in Singapore and Bangkok, and no doubt it frequently occurs elsewhere in the tropics, as constitutional deterioration, with heat, moisture, and the very general presence of the spores of penicillium, aspergillus, and mucor provide favourable conditions for its development.

Symptoms. — Sensations of blocking and stuffiness, deafness, itching, and yellowish watery discharge, with the presence of soft wool-like substance in the meatus, are the leading features. Intense pain usually means the advent of diffuse inflammation, a not infrequent complication. Microscopic examination will settle the diagnosis.

Treatment.—Removal of the fungus, repeated syringing with warm perchloride of mercury lotion, 1 in 5000, and subsequent instillation of alcohol, thorough drying with wool, and dusting with some soothing antiseptic powder constitutes the treatment recommended. It will probably have to be repeated.

(*e*) Pinta.—*See* vol. viii.

(*f*) Piedra.—This disease of the hair is confined to the inhabitants, more particularly the women, of the United States of Colombia.

At irregular intervals along the hair-shaft, minute hard pigmented and gritty nodes develop, which crepitate when the hair is combed or shaken. They first occur about half an inch from the point of exit of the hair, and completely invest it; many may attack a single hair. The disease is not contagious. Although barely perceptible, the nodes are easily felt, and when well developed are not unlike pediculi (nits). Only the head is involved, and the affected hair is said to be weakened and to smell acid.

The nodes are rather hard, and are deeply pigmented on the surface. If examined microscopically after treatment with ether and liquid potassæ, they are found to consist of honeycomb masses of mycelia and spores. These latter are large, angular from pressure, and joined together by a cement-like material containing minute rod-like filaments. Evidently, therefore, piedra is a fungus growth, but it is thought to be predisposed to by the mucilaginous oil used as hair-dressing by native women, or by the water of certain streams. From its frequent occurrence in warm valleys, heat also appears to favour development.

Treatment.—Cleanliness, the application of epiphyticides, or, if obstinate, shaving the affected hair is the treatment recommended.

Parasites

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Introductory. — Ringworm has during the last few years received a great deal of attention, thanks mainly to the exhaustive investigations of Sabouraud, especially as regards the differentiation of the various fungi, their microscopical appearances, cultivation, and botanical relations generally. And although the discussion of these points has been somewhat academic, and has not up to the present led to any advancement

in the way of treatment, yet it has stimulated thought and breathed life into a subject which had fallen into the rut of the commonplace.

However interesting an historical survey of ringworm from the etiological point of view might be, the matter cannot be dealt with in this place.

Leslie Roberts's opinion that the ringworm fungi exert a keratolytic action on the hairs is probably correct. The disintegration which occurs in the nails when they are attacked is in favour of it, as are also the observations of Professor Marshall Ward on a horn-destroying fungus, *Onygena equina*.

As to the saprophytic existence of the ringworm fungi, it is perfectly reasonable to suppose that such is likely, and that the parasitic development is accidental as Sabouraud and Bodin have suggested; but the idea cannot be considered as having been originated by them, as it has occurred to other observers independently. What is known of actinomycosis also points in the same direction. The polymorphism of fungi and their extraordinary susceptibility to their nutrient environment are known.

Some authors (Sabouraud, Bodin, and others) have split up the various fungi parasitic on man into a great number of kinds. For all practical purposes it is not necessary to follow in their footsteps, but as far as ringworm of the scalp, body, beard, and nails, as commonly met with in Britain, is concerned, the following only need be considered: *Microsporon Audouini* (or so-called small-spored fungus), *Trichophyton megalosporon endothrix* and *Trichophyton megalosporon ectothrix* (both commonly referred to as the large-spored fungi). In addition to these, other fungi must also be alluded to, such as: *Microsporon furfur* (Tinea versicolor), *Microsporon minutissimum* (Tinea erythrasma), exotic or so-called tropical fungi (unclassified) (of Dhobie itch — Tinea imbricata — Carate), the fungus of Tinea nodosa.[1]

To avoid needless repetitions, the methods of examination will be briefly stated, but the microscopical appearances of the various fungi, together with the cultural aspects of some of them, will be referred to under the respective diseases.

Method of Examination.—*Hairs.*—It is of primary importance to examine those hairs which are affected. This can only be carried out by searchiug for them carefully with a lens. It is no use pulling out hairs indiscriminately. The diseased hairs are bent, broken, twisted, sometimes displaying a powdery sheath (as in *Microsporon Audouini*, or they may appear as dots or as very short stumps, which sometimes require digging out with the epilating forceps (as in some large-spored cases). Special care in selecting suitable hairs is also needed in ringworm of the beard, and in the latter condition it may be necessary to examine several stumps. When there are crusts, good stumps for examination will be sometimes found adhering to their under surface on removal.

Scales.—As to ringworm of the body, the margins of the rings should be gently scraped with a scalpel, but it is necessary to go deeper than the merely superficial layer. Lanugo hairs are in this way frequently removed with the scales, and they may sometimes display the fungus.

Nails.—The suspected nail should be scraped with the sharp edge of a slide, going pretty deeply.

In all cases when ointments have been used, after preliminary treatment (on the slide) with a little ether to get rid of fat, stumps and scales should be examined in a drop or two of liq. potassæ, B.P. (about 6 per cent), but in the case of nail-scrapings a 40 per cent solution should be employed. The latter strength is used in all cases by some observers, and the slide gently heated over a flame (Sabouraud). This method certainly clears up the preparation more rapidly. Gentle pressure on the coverslip and running in a little more liq. potassæ under it will also be found useful.

More than one examination should be made if the discovery of fungus is not immediately successful. Droplets of fat should not be mistaken for "spores." In some cases (nails, beard), the preparations should be again examined after soaking for some hours, when the fungus will, if present, come well into view.

Method of Staining.—For all practical purposes the examination in liq. potassæ is quite sufficient, and is really the best way of studying the parasites. But if permanent preparations are desired it is necessary to stain. There are many methods, but the following, for which I am indebted to Dr. Brongersma of Amsterdam, I have found answer well. Staining ringworm hairs requires some practice.

Hairs.—1. Place selected stumps on a clean slide, and get rid of fat with ether.

2. Dry with blotting-paper and add a little gentian-violet-aniline solution (prepared by shaking equal parts of aniline oil and water, and filtering aniline water, to which a little saturated alcoholic solution of gentian-violet is added. Mix.): 5 minutes.

3. *Carefully* dry with blotting-paper.

4. Add potassium iodide—iodine solution (as used in Gram's method—or make it by dissolving a crystal or two of iodide of potassium and of iodine in a little water): 1 to 5 minutes.

5. Dry with blotting-paper and add a drop

[1] The fungus of Tinea favosa has been dealt with under "Favus," vol. iii.

or two of aniline oil, followed by aniline oil acidulated with a drop or two of hydrochloric acid, and get rid of as much of the stain as possible. The acid aniline is got rid of with plain aniline oil, and the latter by means of xylol.

6. Wipe away excess of xylol, and mount in Canada balsam. (The preparation should be examined at stage 5 to see it is not too dark.)

Scales and Nail-scrapings.—Place on a slide, and add a little 5 per cent solution of acetic acid. Spread out the preparation by rubbing between two slides; fix (as much as is possible) over a flame in the usual way, and proceed as above.

Adamson's method is as follows, and can be applied after examining in liq. potassæ (as can also the method already described):—

1. 5 to 10 per cent solution of liquor potassæ on a slide: 10 to 30 minutes.
2. Wash in 15 per cent alcohol in distilled water.
3. Dry on slide, and, in the case of scales, fix by passing through the flame.
4. Stain in gentian-aniline-violet (a few drops of saturated solution of gentian-violet in aniline water): 15 to 60 minutes.
5. 1 to 5 minutes in Gram's iodine solution.
6. Decolorise with aniline oil: 2 or 3 hours, or longer.
7. Remove aniline oil with blotting-paper, and mount in Canada balsam.

Method of Cultivation.—The fungi will grow on a variety of media, including potato and so forth, at room temperature.

I have used the following formula:—

Water 1 litre, maltose 40 grammes, peptone 10 grammes, agar 15 grammes, run into test-tubes (sloping) or Erlenmeyer flasks (flat bottles are also useful).[1]

But there are others equally good. The point is always to use the same uniform medium for purposes of comparison, as fungi are very susceptible to very minute differences in their nutrient environment.

Tinea tonsurans (*Tinea trichophytina, Ringworm of the scalp, Teigne tondante, scheerende Flechte*).—This condition may be due either to Microsporon Audouini or Trichophyton megalosporon endothrix (for Trichophyton megalosporon ectothrix, *see* "Kerion," *infra*).

Clinical Appearances.—Microsporon Audouini.—In a typical untreated case the diseased area is circular, more or less scaly, sometimes very markedly so, with numerous short, bent, broken, twisted hairs, growing usually in various directions. Exceptionally, some of the short stumps may go off to a point, like an inverted note of exclamation, whilst others in the patch are bent at an obtuse angle. The diseased hairs are usually whitish, opaque, and exhibit a powdery sheath about their proximal end, and for some way up the shaft, well above the level of the scalp. As a rule the patches are multiple, well defined, and not inflamed, but sometimes merely reddened only. Beyond the main patches smaller satellite areas are often present. There are various deviations from the type, either as a result of long duration or specially acute spread, when the greater part of the scalp may be diffusely involved and scaly, with more or less ill-nourished hair still present here and there; or, the aspect may be altered by previous treatment (ink,[1] ointments, and so forth), and the characteristic powdery sheath absent. The diseased hairs are lustreless, and may be curled like wool. Occasionally a patch may be bald, and at first sight look like alopecia areata.

Diagnosis.—Microsporon tinea tonsurans is the most common form of ringworm in this country. One hundred consecutive cases (exclusive of kerion) microscopically examined by me in Dr. Radcliffe Crocker's clinic at University College Hospital showed that ninety-six were microsporon and four only trichophyton megalosporon. In France the proportion of the latter is much larger, whilst in Germany and Italy microsporon is extremely rare, or practically unknown, the prevalent parasites being trichophyton megalosporon. In the east end of London, where there are many Jews from Poland, Germany, Russia, the large-spored fungus (and favus) is more common.

Where there is loss of hair in patches in a child, ringworm must be first considered. In the disseminated forms great care is required.

The main *microscopical features* of *microsporon Audouini* are the sheath of spores surrounding the diseased hair to a varying extent, and the irregular arrangement of the spores, the units being crowded together. The small refractile spores, with a faintly greenish tint, are all outside the hair, but inside it a delicate mycelium, running more or less parallel to the shaft, can be made out after some soaking and pressing down the cover-slip to detach the sheath.

Cultural Appearances.—On maltose agar the growth has a delicate, white, and fluffy appearance, radiating from a centre.

Differential Diagnosis.—Ringworm must not be mistaken for mere scurfiness of the scalp (*pityriasis capitis*), nor for a *seborrhœic* condition, as the consequences might be serious, owing to the contagiousness of the disease and its rebelliousness to treatment. This mistake is not infrequently made as a result of neglecting a very simple microscopical examination. Sebor-

[1] This can be obtained from Mr. Doudney, Conjoint Colleges Laboratory, Examination Hall, Victoria Embankment, London, W.C.

[1] Common writing ink was recommended by Celsus in the treatment of *areæ*, lib. iv. cap. vi.

rhœic conditions are diffuse, and so are some ringworms, but in the latter the diseased hairs, and so forth, would put one on the right road.

Eczema of the scalp may sometimes complicate and mask a ringworm. In such a case the microscope will be found invaluable.

In *psoriasis* the examination of other parts of the body, especially the elbows and knees, would prevent mistakes.

Alopecia areata is in smoothly bald circular areas, or in the form of a band round the head, either without a vestige of hair, or in recovering cases with a very fine lanugo growth. The characteristic point of exclamation hairs (!) of *alopecia areata* should be looked for in active spreading patches, especially at the borders.

Trichophyton megalosporon endothrix.—In this form the patches are not always so well defined, and develop more slowly. As a rule they are smaller, vary more in shape, and are but slightly scaly. The stumps are few and far between, and require careful looking for. They are brittle, and, as a rule, break off short very near or at the level of the scalp, in the latter case looking like black dots. But stumps one-fourth of an inch may occasionally be found. There is no powdery sheath as in the *microsporon* form. The patches are sometimes quite bare (bald ringworm); in others the denudation is incomplete, with a certain amount of ill-nourished hair still present. Again, patches may be somewhat reddened and slightly crusted in neglected, dirty cases. Very small, bare satellite patches are sometimes observed.

The chief *microscopical character* of this parasite is the arrangement of the very short segments (not strictly spores) of the mycelial filaments in chains, situated inside the hair (hence *endothrix*). This sharply differentiates it from microsporon Audouini. In the former the "spores" are somewhat larger (hence *megalosporon*), but the difference in size is not a point to lay much stress upon in practice.

The "sporulated" mycelial filaments run more or less parallel to the hair-shaft, and when plentiful they are closely applied to one another. The ladder-like appearance or squareness of the "spores" (or short segments) has been insisted on as opposed to the barrel-shaped form of corresponding structures in the *ectothrix trichophyton*, but this is no doubt merely a matter of position due to the situation of the *endothrix* within the hair. In advanced disease of a stump the fungus may break through and come to be situated partly outside the hair. The parasite in such cases is sometimes called *trich. meg. endo-ectothrix*. But, according to Sabouraud, the *endothrix* fungus is only met with in man, the *endo-ectothrix* being of animal origin.

Cultural Appearances.—On maltose agar the growth is circular, radiating, white, and raised in the centre at first, but with age becoming yellowish in tint and subsiding in the centre, giving rise to a crateriform appearance. Occasionally the growth has a violet hue, which Bodin says is of frequent occurrence in Italy. He gives this fungus the name of *trichophyton violaceum* of Sabouraud.

Differential Diagnosis.—In this kind of ringworm the bald patches, which are sometimes seen, must be distinguished from *alopecia areata*. The points in favour of the former would be the brittle short stumps or dots, exhibiting the endothrix fungus, and the absence of point of exclamation hairs (!).

Kerion.—In this condition the reaction caused by the fungus is very marked. It is really a pustular folliculitis, usually due, in my experience, to *trichophyton megalosporon ectothrix*, giving rise to a well-defined suppurating patch, sometimes very large, markedly raised, more or less convex, occasionally dome-shaped, with fluctuation, but there is no surrounding induration. The stumps and hairs are loose in the follicles, and can be readily removed. Pressure gives exit to thick, glairy sero-pus.

Trichophyton megalosporon ectothrix is the parasite of this form of ringworm. Microscopically, the mycelial filaments are situated outside the hair, and are "sporulated" in a chain-like manner, the individual short segments being somewhat barrel-shaped. The fungus, by disintegrating the shaft, may penetrate into the hair.

Trich. meg. endothrix and *microsporon* have been described as occurring in kerion.

Cultural Characters.—On maltose agar the growth of *trich. meg. ectothrix* is of an opaque dead white, with a small raised button-like centre, from which the fungus radiates outwards in a stellate manner, presenting a sprinkled powdery appearance at the periphery.

Differential Diagnosis.—A kerion has a superficial appearance to a carbuncle, but the absence of an indurated border and of the purplish hue would prevent a mistake which has been made. The fact that the patient is a child is of importance. Nor must it be taken for an abscess. Attention to the details given above should make an error impossible.

Etiology.—Ringworm of the scalp is a contagious disease due to parasitic fungi, *hyphomycetes*. In families and schools it may spread in a most discouraging manner, either from child to child, or through contaminated headgear, brushes, and so forth. Ringworm may also be contracted from animals.

Age.—Tinea tonsurans usually affects children, but very exceptionally it may occur in adults. It is important to bear the latter point in mind, and in a doubtful case of the kind a microscopical examination should never be neglected.

Treatment and Prognosis.—Ringworm of the scalp is a very difficult disease to treat, and requires much care and patience on the part of

both medical attendant and the persons in charge. Every now and then wonderful remedies are trumpeted forth in the journals, which cure ringworm in a very short time. These announcements should always be received with scepticism. At times authors of these brilliant cures display much ignorance of the subject. In other instances cases put down as cured are really not cured at all. There is no doubt, however, that some cases are very amenable to treatment, especially if the parents carry out instructions carefully, or perhaps owing to the condition of seed or soil. But this is not the rule in practice, especially among the out-patients of a hospital, when treatment is carried out in a very perfunctory manner.

The *prognosis* should therefore always be very guarded. It has been said that the *trichophyton endothrix* are more readily cured than *microsporon* cases, but this cannot be relied upon. I have seen cases of the former kind prove extremely obstinate and last a very long time (two years or more), although the children were well looked after. Moreover, the admittedly chronic *microsporon* cases form the great majority of the ringworms of the scalp observed in this country. In this connection *kerion* (*trich. meg. ectothrix*), which looks very formidable, is more readily cured, the acute suppurating process being curative in itself.

Where it is possible, the head should be shaved when the diseased areas are numerous or the ringworm diffuse, leaving, if necessary, a fringe of hair all round; but complete shaving is preferable. It should be done every week, and instead of using a shaving-brush, which is liable to become infected, pads of wool should be employed and burnt after use. An ethereal liquid, or at least a mild antiseptic soap, should be used. After shaving it is well to rapidly swab the scalp with some wool and a diluted antiseptic solution (sanitas, 1 in 10, or carbolic acid, 1 in 40), and dry, without rubbing, with another clean piece of wool. When shaving is not possible the hair should be kept closely cropped all over the head. Hats and caps must be lined with clean tissue paper every morning, and the paper lining burnt at night.

The important point is to have the affected areas well under the eye to allow of the remedies being applied to the right places, and not smeared over the hair and scalp promiscuously, as is so often the case. Ointments should be applied not only to the patches themselves, but all round them also, where the disease spreads.

The applications are legion; but I have found the following answer well in Dr. Radcliffe Crocker's clinic, and in private, viz. Cupri oleat. ʒj., adipis ℥j., rubbed into the diseased areas night and morning. This loosens the affected hairs by leading to a mild folliculitis. The stumps should be systematically removed when loose (otherwise they will break off in the follicle), with epilating forceps. When the patches appear denuded and smooth, a good sign, one of the following ointments may be used every day at first, then three or four times a week:—Hydrarg. iodidi, pot. iodidi āā gr. ij.-iij., aquæ ʒj., lanolini ʒiij., adip. benz. ʒiv.; or, Resorcini ʒj., adip. benz. ad ℥j.; or, Sulph. subl. gr. xx.-ʒj., thymoli ʒss., adip. benz. ad ℥j. One of these, or some milder parasiticide ointment, should be continued to the patches once or twice a week for some time after the ringworm is apparently cured, especially if there should be areas of scurfiness or scaliness present.

With regard to washing the head, it is important to do this carefully. Careless shampooing is but too apt to spread the disease, and want of success can sometimes be distinctly traced to it. When the head is shaved there is no need for such a procedure, but when it is done the affected areas should be covered while the other parts are carefully dried.

When on careful examination with a lens a diseased stump or two are still found, these should be treated individually by means of a drop of croton oil introduced into the hair-follicle on the point of a needle on a holder. This gives rise to a slight pustular folliculitis, when the loosened stump can be readily removed with forceps. Croton oil should not be applied to stumps lying close together, to avoid coalescence of the pustular lesions.

Formalin was at one time strongly advocated, but it appears to have already gone the way of other much-vaunted cures. I have seen scars the size of a sixpence and over as a result of its application. It is easy enough to cure ringworm in this way, but parents do not bless you for producing indelible scars on the heads of their children.

Chrysarobin is apt to lead to erythema, and, when applied near the eyes, to smart conjunctivitis. Besides, it stains linen badly. But it is sometimes useful, with care as to above drawbacks, thus:—Chrysarobini gr. x., ung. zinci oleat., ℥j., also combined with cupri oleat. ʒj., or with ol. amygdal. ʒiij., lanolin ʒv., instead of the ung. zinci oleat.

In infants the disease is more like *tinea circinata* (*vide infra*), and is more readily cured by sulph. sublim. gr. xv., acidi carbolici ♏xx., adipis ℥j. (or ol. amygd. ʒiij., lanolini ʒv., instead of the lard).

In older children Coster's paint (pigmentum iodi et olei picis, U.C.H. Pharmacop. = iodine 120 grains, light oil of wood tar one ounce) sometimes answers well. It should be applied with a stiff brush (a paste-brush, with the bristles cut short), after well shaking the bottle. The scab produced is removed with forceps, bringing away diseased hairs. The paint can be again applied after rubbing with soap and

flannel. Oil of cade or creasote instead of the wood tar is preferred by some.

Diseased hairs can be got rid of by painting on several layers of *collodion*, and removing it with forceps. This is followed up by an ointment.

Harrison's treatment (as explained in the section on *Tinea unguium* in "AFFECTIONS OF THE NAILS," vol. vi.) must be employed with great care, and under the medical attendant's supervision.

All strong remedies must be used carefully to avoid scarring.

There are many other formulæ, but the foregoing will be found all that is required. The mode of application is the thing—that and perseverance.

Kerion is more or less self-curative, but nature can be effectually assisted by art, for if allowed to go on indefinitely the condition may lead to baldness. I can testify to the formula recommended by Dr. Radcliffe Crocker, viz. Sulph. sublim. ʒss.-ʒj., acidi carbolici ♏xx.-♏xxx., adipis ʒj., and pulling out the loosened stumps. Incisions should not be made, however great the temptation.

Certificates.—The medical attendant is sometimes asked for a certificate that the case is cured, so that the patient may go to school or enter some public institution. This is a matter which incurs responsibility, and, in the event of an error, gives rise to much mortification and unpleasantness all round. It is no easy thing sometimes to say positively that a ringworm of the scalp is cured. Careful search should be made with a lens for diseased stumps, and if any suspicious hairs be discovered they should be examined microscopically. Slight scaliness in patches is suspicious. In a cured case the new hair grows evenly and regularly, and has a characteristic set. When there is any doubt the signing of the certificate should be deferred, and an ointment used occasionally as explained under treatment. It is important to be able to say "no" firmly, for parents get restive, and naturally so after a long and tedious course of treatment.

Prophylaxis and Social Aspect.—This is a matter which must not be neglected. Every care should be taken that healthy children do not run any risk of contracting the disease. Caps, brushes, combs, and so forth may convey the germs of ringworm to virgin scalps. It is not necessary to segregate the sick from the well, but an eye should be kept on both, and every precaution taken which common sense suggests to prevent spread.

In Paris there are special schools for children suffering from ringworm. The sum total of lost schooling is in this country very great. But our educational system, regardless of expense, is so extravagant as it is, that it is doubtful if the pockets of the middle classes can stand more picking for special schools and teaching staffs. It would be money better spent, however, than throwing it away on useless inebriates and making it soft for the careless and idle generally.

TINEA CIRCINATA (*Trichophytie circinée; Herpes circinatus*).—Ringworm as it affects the skin apart from the scalp and beard must now be dealt with. Tinea circinata occurs, as the name indicates, in rings, either alone or as a complication of tinea tonsurans.

The lesions are usually reddened rings with a papular, or sometimes a vesiculo-papular periphery, the papules and the erythema round them forming a border varying in width, the central parts being clear. There may be several rings one within the other (concentric), sometimes three or four, or more. Or an inner smaller ring may touch the outer larger ring tangentially. Instead of a distinct ring, commencing as a small spot or patch, with a progressively extending border, clearing as it goes, there may be insignificant, slightly reddened or almost pale, raised, scaly patches, of little finger-nail size or less, and uniform on the surface. The latter have been considered to be characteristic of *microsporon Audouini*, while the ringed forms, with more inflammatory reaction, have been referred to *trichophyton megalosporon endothrix*. I have seen the small uniform patches about the neck in a case undoubtedly due to the latter fungus in some cases, and on the other hand, well-marked, reddened rings in *microsporon*.

The rings may be multiple, very numerous, and scattered over the body and limbs.

Tinea circinata is not uncommon in adults, on the face, limbs, and hands. Mothers may contract the disease from tinea tonsurans in their children. On the back of fingers in an adult man I have found the fungus (*trich. meg. endothrix*) in the hairs.

In the scalp of infants the lesion is usually a distinct ring spreading superficially and sparing the young hair. Occasionally a similar thing is seen on the scalp of older children.

About the beard and neck of men, reddened rings, with slight scaliness and little reaction, sometimes occur, but tinea sycosis (*trich. meg. ectothrix*) is more usual in them.

Lesions comparable to kerion of the scalp, but on a smaller scale and with less reaction and swelling, are seen in adults, about the upper limbs usually. The patch is raised, markedly inflamed, with numerous aggregated follicular pustules, especially about the peripheral parts. This has been called CONGLOMERATIVE MULTIPLE PUSTULAR FOLLICULITIS by Leloir, but it is now known to be due to *trich. meg. ectothrix*. In a case I observed there was a single patch on the forearm, and no secondary pus lesions anywhere. Microscopically the fungus was an ectothrix, and this was confirmed

by cultivation on maltose agar, a pure culture being obtained from the first. This shows decisively that *trich. meg. ectothrix* is a pus producer on its own account without the intervention of pus cocci, and supports Sabouraud's opinion.

Etiology.—Tinea circinata may be contracted from children suffering from tinea tonsurans, or from animals. The kerionic cases can often be traced, especially in country districts, to calves, which frequently suffer from ringworm.

Diagnosis.—In addition to the above clinical features, a microscopical examination of the scrapings will generally be rewarded by the discovery of fungus.

I have examined a number of tinea circinata lesions, and I have come to the conclusion that the kind of fungus, whether *microsporon* or *trichophyton megalosporon*, can be made out in the majority of cases by a microscopical examination, the two varieties of *trichophyton*, *endothrix* and *ectothrix*, requiring, however, further differentiation by cultivation. But even in the case of the *trichophytons* the clinical features of the lesions, together with the microscopical appearances, would help to arrive at a pretty accurate conclusion.

The *microsporon Audouini* appears in the scrapings as coarse and irregularly branching mycelium, varying but slightly in diameter, more so in length, but as a rule running short. The branching occurs laterally at right angles to the main filament, and these branches are usually terminated in a spheroidal manner at their free end. The mycelium exhibits small refractile dots, which are not "spores," but probably fatty particles; and it is generally unsegmented.

On the other hand, the *megalosporon* is found as long, jointed, usually straight, dichotomously branching mycelium, which is here and there sporulated, or more correctly, divided up into very short segments. As to the dichotomous branching, I have seen the two daughter branches spring respectively from divisions of a short mycelial segment (or "spore"), itself longitudinally segmented. The segments vary in length, being shorter the nearer they are to the chain-like or rosary stage. The width varies also, the filaments being at times very slender and plain, or with long segments.

As to the above distinctions which I have drawn between *microsporon* and *megalosporon*, I have confirmed my observations by cultivations, and also by the examination of tinea circinata scrapings from patients who were also suffering from tinea tonsurans of either undoubted *microsporon* or *trich. megalosporon* origin.

Differential Diagnosis.—The diagnosis as a rule offers little difficulty, but I have seen the primary patch of *pityriasis rosea* taken for and treated as a ringworm. Moreover, pityriasis rosea in the generalised eruptive stage sometimes occurs in rings scattered about the body, which look something like a multiple tinea circinata. Indeed, Hebra and Kaposi called it *herpes tonsurans maculosus et squamosus*, and attributed it to a fungus, but which, as far as I know, they never demonstrated. In pityriasis rosea the eruption about the trunk and upper segments of the limbs, consisting of little finger-nail sized, rosy, very delicately scaly, oval patches distributed in the lines of cleavage about the ribs, with their long axes parallel to the latter, would differentiate that disease from multiple ringworm, which occurs in irregularly scattered rings. There is no fungus in pityriasis rosea, which in its development resembles an acute exanthem.

There should be little difficulty, with a little care, in distinguishing tinea circinata from a well-defined patch of *eczema*, and the fact that a fungus was present would clear the matter up at once.

Seborrhœa papulosa vel circinata affects the inter-scapular and inter-mammary regions, and it is associated with seborrhœa capitis. The rings are made up of small papules, but they are very small and delicate, and do not spread peripherally after the fairy-ring manner of tinea circinata.

On the palms and soles tinea circinata may occur, but it is extremely rare, as dry scaly lesions, which have been mistaken for *tertiary palmar and plantar syphilides* or a dry *eczema*. The assistance of the microscope has in such cases cleared up the diagnosis.

In the case of multiple small rings, altered by treatment, and especially about the face, the idea of *syphilis* has also occurred, but the absence of corroborative luetic symptoms and careful examination would prevent such a mistake.

Tinea Barbæ.—(*Tinea Sycosis; Barber's Itch; Trichophytie sycosique; parasitäre Bartfinne.*)—In addition to tinea circinata about the beard, above described, ringworm of this region more frequently presents itself as an irregularly lumpy, swollen, boggy lesion, with distinct pustules scattered about the primary focus; but discrete pustular and small nodular lesions may also occur in other parts of the beard. This condition corresponds to kerion of the scalp. The brawny inflammation may at times be very marked. The hairs can be readily removed when suppuration has occurred.

Diagnosis.—This will usually be assisted by an examination of some of the hairs, when the fungus may be found. In some cases the *trich. meg. ectothrix* is readily discovered, after a little soaking in liq. potassæ, at the first shot as it were, but in others several hairs require to be examined, and repeatedly, before success is attained.

Differential Diagnosis.—It differs from *coccogenic sycosis* (the non-parasitic sycosis, as

it used to be erroneously called, but now known to be due to pus cocci) in its rapid spread, multiple foci, and chiefly the boggy, nodular swellings.

In *eczema* of the beard the process is acute, more superficial, and accompanied by serous exudation; at times vesicles can be observed; it is a more uniform patch in appearance, and the skin *between* the hairs is invaded, differing in this respect from the pustular folliculitis of tinea.

Etiology.—The disease frequently starts after being shaved at the barber's. The *fons et origio mali* is the brush, and *not* the razor. The disease may also be contracted from animals (cattle chiefly).

Treatment.—It is exactly the same as for KERION, which see.

TINEA UNGUIUM has already been dealt with by me under "AFFECTIONS OF THE NAILS," vol. vi. Suffice it to say in this place that any long-standing deformity of one or more nails, with roughness, irregularity of the surface, brittleness, and so forth, together with an asymmetrical distribution, should make one suspicious of ringworm. A further point in the diagnosis would be the rebelliousness of treatment. A previous diagnosis by another, that the condition was "constitutional," should, of course, not be accepted without further investigation.

I have seen the disease occur in two sisters, aged about forty, in whom it had existed for twenty years and more. In both it commenced in the same finger-nail. The cause had never been discovered until I took the trouble to examine some nail-scrapings, and found the fungus, a thing any one might have done. I was able to cultivate the *trichophyton megalosporon endothrix* from one of these cases. But *trich. meg. ectothrix* has been more frequently found.

The nails are sometimes affected in old tinea tropica cases.

Treatment and so forth (*vide loc. cit. supra*).

TINEA CRURIS SEU AXILLARIS (*Tinea tropica; Eczema marginatum*). *See* p. 190.

TINEA VERSICOLOR. — (*Pityriasis versicolor; Chloasma* (old style); *Kleienflechte.*)—This disease, which is due to a fungus, *microsporon furfur*, occurs in patches of various shades of fawn and sepia brown, usually situated on the trunk. The patches may be small, discrete, and few in number, but it is more usual for them to occupy large, irregularly but well-outlined areas about the chest and back, owing to the fact that the disease, giving very little, if any, trouble, is allowed to spread unchecked. In some cases a great part of the trunk may be occupied by a sheet of discoloration, with numerous satellite spots beyond, thrown out like outposts. In this way it may spread to the limbs and neck, but it is very rarely seen on the face in this country. The latter situation is, however, more common among the natives of India, according to Arthur Powell, who kindly sent me scrapings, in which I was able to demonstrate the typical fungus exactly as it is seen in this country. Cultivation on maltose agar gave a fluffy white growth, very aerial, without any special arrangement; but some doubt having been expressed by so good an observer as Colcott Fox, I cannot be dogmatic on the point of genuineness of the growth.

In some instances the colour has been so dark as to deserve the name of *pityriasis nigra* (from Willan and others), but Hebra considered that condition was the pigmentation of chronic pediculosis corporis (*see* article on "PEDICULOSIS," vol. vii.). Leitz, when at Honolulu, pointed out that the coloured races presented a white or grey discoloration of the skin.

It usually occurs in adults, but it has been seen in a boy of about eight (Sidney Phillips). It has frequently been observed in the phthisical, but this is probably due to the sweating. I have seen it recur again and again in a case of rheumatoid arthritis, no doubt for the same reason. People who have a rather greasy skin, and wear thick vests night and day (a not uncommon, but unhealthy and uncleanly habit), have appeared to be more prone to it.

The disease is contagious, but not in a marked degree, as man and wife may not contract it one from the other after years of cohabitation.

Diagnosis.—Fawn or sepia brown patches on the trunk should suggest the idea of tinea versicolor. The discoloration is *not* a true pigmentation, but when the parts are scraped with a scalpel or with the nail, the discoloration disappears. The examination of these scrapings in a little liq. potassæ will reveal the presence of the parasite, viz. shortish mycelial elements, with clumps of rounded spores, usually with a central dot, here and there in the preparation. These clumps are characteristic.

Differential Diagnosis.—Owing to the discoloration, and especially when there are numerous discrete small patches, cases have been erroneously taken for *syphilis* and treated as such. This is due to leaning on one symptom exclusively, apparent pigmentation, without looking for corroborative evidence of lues. This mistake should never be made.

True *chloasma* is in the skin, and should not offer any difficulty.

Leuco-melanoderma is also a true pigmentation (melanoderma), followed by depigmentation (leucoderma), the white contrasting parts encroaching on the dark skin. This condition is symmetrical, affects the hands, wrists, and neck chiefly, but also other parts (face, and so forth). The mode of development should also be taken into account.

Pityriasis rosea in its declining stage sometimes leaves very faint fawny discoloration

behind. For other features, *vide supra*, Tinea circinata: Differential diagnosis.

As to *seborrhœa papulosa*, a little attention will readily distinguish it (*vide* Tinea circinata, *loc. cit. supra*).

Tinea versicolor must also be differentiated from *tinea erythrasma* (*vide infra*).

Prognosis and Treatment.—The disease can be got rid of with attention and perseverance. I have found the method recommended by Radcliffe Crocker answer every purpose. The patches are first thoroughly washed with hot soap-and-water, and the epidermis well brushed with an old nail-brush (used for this purpose only, of course, and disinfected), and the following lotion well soaked and rubbed in twice a day: Sodæ hyposulphitis ℥j., aq. ad ℥viij. It is important to go on with the treatment for some time after the apparent cure, to get rid of the fungus completely. Failure to do this invites recurrences. The under-flannels, pyjamas, night-shirts, etc., should be well boiled, or, if old and valueless, burnt.

Tinea Erythrasma (*Erythrasma*).—This disease, which is due to a fungus, *microsporon minutissimum*, is an uncommon condition in my experience, and is more frequently met with in men than in women, but as it is an insignificant affection and gives no trouble, cases no doubt escape observation. It occurs about the folds and clefts of the body, such as the armpits, groins, genitalia, and buttocks.

It occurs in slightly scaly and reddened well-defined patches of irregular outline and of limited extent, but sometimes by spreading unchecked it may involve a large area. There may be slight itching.

Diagnosis.—A patch with the above features having lasted for years should suggest erythrasma. Scrapings should be examined for the fungus, *microsporon minutissimum*, which consists of very slender mycelial filaments, more nearly approaching bacterial elements in width. The mycelium is segmented, the segments varying in length. In looking for this *minute* fungus a $\frac{1}{12}$ oil-immersion lens should be used.

Differential Diagnosis.—Tinea erythrasma must be distinguished from *T. versicolor* and *T. cruris*, but attention to the characteristics of these two conditions and their respective fungi would suffice to exclude them.

Treatment.—It is the same as for *tinea versicolor*, care being taken to avoid recrudescence by continuing the treatment for some time after apparent cure.

Tinea Nodosa.—This is a disease of the hairs of the beard and moustache. It was named by Cheadle and Malcolm Morris, who demonstrated the fungus.

Clinically, the hairs are ensheathed with a sticky brown concretion, making them adhere to one another.

Microscopical and Cultural Appearances.—I have examined some moustache hairs kindly handed to me by Dr. Radcliffe Crocker. I found, when first examined by reflected artificial light, and after soaking in liq. potassæ B.P., that the sticky substance was made up of masses of fungus; but what was particularly striking was the arrangement of the "spores" in rows, more or less at right angles to the shaft of the hair, looking like closely aggregated segmented mycelia, bound together by a cement substance secreted by the fungus. The rows of mycelia were distally (*i.e.* at free ends) bounded by a thin dark line with an outer narrow pale zone, evidently made up of the same sticky substance, while at their proximal ends (*i.e.* attached to shaft) they became detached more or less *en masse* when the cover-slip was pressed down firmly. The fungus did not apparently invade the hair. On French proof agar (maltose agar), a cultivation was obtained which consisted of two portions, central and peripheral. The former was more or less oval, slightly raised and convex, yellowish white, glistening, and apparently made up of fungus and a viscous substance. The peripheral part was made up of a delicate white radiating growth.

Diagnosis.—Attention to the above details would distinguish it. It is not common.

Treatment.—The affected regions should be shaved, and kept so for some time. Where this is not possible the affected hairs should be clipped, and the parts sponged or brushed over with the following lotion: Resorcini ʒss, acidi acetici ʒvj., sp. vini rect. (vel aq. coloniensis) ℥j., aq. (vel aq. ros.) ad ℥iv.

Piedra.—Spanish for *stone* (*trichomycose nodulaire* (*see* p. 191) of Juhel-Rénoy).

Carate is a disease of equinoctial South America, and includes a number of ringworms, varying in colour from race to race. This may be violet, blue, red, and so forth. Some are special to whites, others to the natives, others again to half-castes.

They occur in patches, especially on the uncovered parts of the body. The patches are scaly, with irregular but well-defined margin. In time they become achromic and cicatricial. They are very chronic and rebellious to treatment.

Montoya y Florez has investigated the fungi in Sabouraud's laboratory. In the scales aspergillus-like fructification has been found, with a retiform arrangement of the mycelia. An interesting fact is, that in some of the scrapings an acarus rather larger than our acarus scabiei was discovered. Sabouraud suggests the possibility of the spores of the fungus being conveyed by the animal parasite, as the latter is very common, especially in old men of the lower classes in Colombia.

Treatment.—It would be the same as for tinea imbricata.

Bulpiss has been described by Lerch as

occurring in Nicaragua. It is said to be contagious and identical with carate (Jackson).

Animal Ringworms.—It can merely be said here that various ringworm fungi have been found in dogs, horses, cattle, cats, and birds.

Pigmentary Affections of the Skin

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The great variety of tints displayed by the cutaneous surface of the body can be arranged in three classes. In fair complexioned persons the pigmentation of the blood may be said to control the complexion, and every pigmentary change in the red corpuscles adds some colour effect to the skin. In persons of swarthy complexion, and still more so in the coloured races of mankind, the innate pigment of the skin masks the colour of the blood. In other cases the skin is pigmented by foreign pigment deposited in the horny layer of the epidermis. These three kinds of pigmentation may be named respectively the hæmic, the parenchymatous, and the spurious. Of these the parenchymatous alone constitutes the true physiological pigmentation of the skin.

The cutaneous tissue elements which convey colour effects to the eye are keratin, liprochromes, and melanin. Keratin in itself is colourless or slightly yellowish; but in ichthyosis it acquires a blackish colour which is highly characteristic of the disease. The liprochromes are the pigments associated with the cutaneous fat. Very little is known as to their nature. In the disease known as seborrhœa nigricans the pigment may be black; more rarely it is yellow or blue (S. flavescens, S. cærulea).

Melanin is an amorphous granular pigment varying in tint from golden brown to black. Owing to its extreme insolubility, no exact chemical analysis of it has been obtained. It probably consists of more than 50 per cent of carbon, with an uncertain quantity of hydrogen, oxygen, and sulphur loosely combined. It is free from iron—a fact which serves to distinguish it from hæmoglobin. Melanin may therefore be regarded as a carbon pigment. In moderate pigmentation the basal, or germinal layer of the epidermis alone is coloured, the superficial epithelium and the underlying cutis being colourless. In deep pigmentation the whole of the epidermis is coloured, while some pigment granules may be seen in the superficial lymphatics of the cutis, in the connective tissue corpuscles, and even, as in some cases of Addison's disease, in the lymphatic glands.

Two views are maintained as to the mode of origin of the pigment. Ehrmann, from his investigations of amphibians and reptiles, concludes that the epithelial colouring matter is elaborated in special connective tissue corpuscles (chromatoblasts or melanoblasts), from material derived from the red blood corpuscles, and he believes that it is conveyed by direct protoplasmic currents flowing through the branches of the melanoblasts into the interior of the basal epithelial cells. Ehrmann's observation of branched pigment cells in the cutis of fishes, amphibians, and other animals, has been confirmed by List. Riehl has observed branched pigment cells in the human hair. In the scalp of a human embryo (five months) Meyerson found the basal epithelial cells in the region of developing hairs devoid of pigment, but other pigmented cells, some of them branched, were observed lying in the epithelium. The same observer has seen branched pigment cells in the hair-bulbs of adults. While it must be admitted that Ehrmann's view rests on the broad physiological analogies which render this mode of origin at least possible, there are many facts relating to the pigmentation of the human skin which cannot be explained on this assumption. Jarish long maintained that the origin of melanin is located in the epithelium, and cited the facts that in the embryo of the frog the formation of pigment takes place before the development of red blood corpuscles, and that the papillæ of coloured hair are usually free from pigment themselves. The researches of Prof. Delépine entirely confirm Jarish's view. According to this authority, melanin is a secretory product of the young epithelial cells, and when formed in excessive quantities passes partly into the lymph spaces of the cutis and partly into the superficial epithelial cells. In cases of obstruction of the lymphatics of the skin "the melanin may accumulate in the lymphatic spaces existing between the point of obstruction and the epidermis." Delépine cites cases of marked pigmentation in which blocking of the lymphatics occurs, such as leprous tubercles with obstruction of lymphatics by bacilli, tuberculosis of the skin, syphilitic gummata, margin of ulcers, irritation of epidermis, cicatricial contraction of corium, the nipple constricted at its base by cicatricial contraction due to irritation of the galactophorous ducts, leading to accumulation of pigment in the core of the papillæ. In all these cases the pigment was chemically tested and found to be of the nature of melanin. These and many other facts which cannot be here cited render it highly probable that melanin is a pigment precipitated from the protoplasm of the epithelial cells. According to Delépine, the pigment is the final term of a metabolic process in which at least one ante-

cedent substance is formed. To this hypothetical substance I shall refer again on account of the importance attached to it by Delépine.

The Correlations of Epithelial Pigmentation

A description of the anomalies of pigmentation should, by right, be preceded by an account of the general laws relating to the formation of melanin, without which the anomalies themselves are unintelligible. Unfortunately our very limited knowledge does not allow more than a mere outline sketch, in which many gaps must of necessity occur.

1. The colour of the skin and hair, so far as this depends on their own pigment, is controlled by heredity; whether much pigment is found or little, or whether it falls to this or that area of the skin, is predetermined by the mutual influence of the sperm and germ *in utero*.

2. Epithelial pigmentation is correlated with the emotional character of the race, family, or individual. It is a popular and universal belief that the complexion is a sign of the temperament or emotional character of the individual, and this belief rests on a sure scientific basis.

3. A fair epithelium when stimulated becomes coloured by the increased formation of melanin. This is a remarkable fact, but one which need not surprise us when we remember that the fair races are descended from dark-skinned prehistoric races. It will help us to understand many pigmentary anomalies if we regard the coloured skin as the real normal type, and the fair or colourless skins as a condition most removed from a state of nature. In the light of this hypothesis, pigmentation following stimulation of the epithelium is merely a reversion to the ancestral or normal type. It is to be noted that the pigmentation has no relation to the nature of the stimulus, for fleas suffice in some, mental shock in others. Further, the precipitation of melanin does not alter the growth relationships of the cells, thus a freckle grows neither more nor less than the surrounding pale parts. But if the stimulation be long continued it may lead to erratic developments of the germinal epithelium, as when epithelioma grows out of a pigmented spot. Delépine has pointed out that all the stimuli capable of acting on gland cells with the addition of light are capable of inducing the formation of melanin. It is a matter of common observation that pigmentation of the skin follows the stimulus of light (actinic rays), dark heat, chemical irritation such as mustard plaster, mechanical irritation as in scratching, the pressure of garters, clothes round the waist, nervous stimulation as in nerve leprosy. As an example of toxæmic stimulation, arsenical poisoning is among the most striking. Other examples of toxæmic pigmentation will be referred to again.

4. Is epithelial pigmentation correlated with the oxidation processes of the body? Although, as stated above, the precipitation of melanin neither increases nor diminishes growth, we cannot avoid the inference that this precipitation implies some change of cellular character. By analogy with the colouring matter of plants, we might presume some physiological function to be attached to the formation of melanin. And according to Delépine this is actually the case. He has collected evidence which, so far as it goes, is favourable to the hypothesis that in the process of pigment formation some pale substance is formed under the influence of light, which is antecedent not only to melanin, but to hæmoglobin. This pale or colourless pre-melanin (or melanogen) is secreted by the germinal epithelial cells, passes into the lymph stream, and combining with iron in the liver, and possibly some other elements, forms the hæmoglobin of the red corpuscles. The final term of the process, namely, melanin, he does not regard as essential to the formation of pre-melanin, so that pale skins may still continue to secrete a part of the elements of hæmoglobin. Dr. Muir, working under the direction of Delépine, was able to show that the percentage of hæmoglobin is raised in cases of arsenical poisoning accompanied by deep pigmentation—a fact which, while it does not prove Delépine's theory, is certainly not opposed to it. Considering that the process of pigment formation, and therefore of pre-melanin, is so extremely irregular, it is difficult to conceive that the cutaneous epithelium is the *primary* source of the mother-pigment. Facts, however, may be cited which favour the idea that the epithelium is a complementary organ to the pigment-secreting suprarenal bodies. Thus in Addison's disease, in which these bodies are generally the seat of tubercular disease, and may therefore be supposed to be incapacitated, we have the well-known deep pigmentation of the skin. Again, all the chronic diseases which are accompanied by asthenia, lowering of blood pressure, and changes in oxidation, such as tuberculosis, syphilis, malaria, cancerous cachexia, arsenical intoxication, senile debility, are accompanied by more or less increased formation of cutaneous melanin. It is not impossible that in these diseases the skin is attempting to supplement the functions of the suprarenal bodies. Possibly even the pigmentation of pregnancy may be explained by the same hypothesis.

Classification of Pigmentary Anomalies

A. *Melanin in Quantities sufficient to Colour the Skin locally or generally.*

True or Melanotic Pigmentation

Racial and sexual.	Actinic and irritative.	Emotional.	Toxæmic.	Neoplastic.	Post-inflammatory.

1. Under the head of sexual pigmentation I

include freckles, lentigo or ephelides, also the formation of pubic hair pigment. It is usual to divide freckles into sun freckles and cold freckles, under the assumption that the former are due to the action of the sun. From the fact that they rarely appear before the eighth year, and that they are the almost invariable congeners of red hair, although they may occur in association with dark brown and black hair, that they do not disappear in winter, and that they are limited to sharply circumscribed spots, we may conclude that their formation is determined by some "freak" of development.

2. *Actinic Bronzing of the Exposed Parts of the Body.*—From the brilliance of colour displayed by animals and plants in the tropics, we may gain some notion of the powerful influence exerted by the actinic rays on the pigment function. Dr. Robert Bowles has drawn attention to the fact that snow-reflected light has greater burning power than direct sunlight. This would appear to be due to the reflection of ultra-violet light from the snow. Bronzing may follow exposure to the electric arc light. Bowles showed that red or orange coloured objects had the power of absorbing the ultra-violet light and so preventing sunburn. Since then, more extended experiments have been carried out by Finsen and others, showing the powerful stimulating action of ultra-violet rays on epithelium. The pigmentation provoked by mechanical and chemical stimulation has already been referred to. "Vagabond disease," or phtheiriasis, is an instance of general pigmentation following prolonged scratching, and is generally associated with malnutrition.

3. *Emotional Pigmentation.*—As might be expected, women are more subject to this form of pigmentation than men.

(1) *Pregnancy.*—The commonest example of this is the darkening of the colour of the nipples in women when they become pregnant. Marlio records a case in which the greater part of the body of a woman became pigmented during her first pregnancy. The liver-coloured patches known as *chloasma* are frequently met with on the temples and elsewhere in women who have been pregnant.

(2) *Hysteria.* — The general tendency to pigmentation, especially marked under the eye, is pronounced in hysterical women.

(3) *Chlorosis.*—Pigmentary anomalies of the blood are largely responsible for the colour of the skin in these cases, but chloasma is commonly observed in these patients.

(4) *Fright or Terror.*—M. Rostan, quoted by Laycock, records the case of a woman who was condemned to death by a Parisian mob during the first French Revolution. She escaped death, but a few days after her skin became as black as that of a moderately black negro.

(5) *Exophthalmic Goitre, Chorea, and Epilepsy.*—In these diseases, which are associated with changes in the emotional character of the individual, pigmentary anomalies have been observed. Féré records more or less universal pigmentation coinciding with the attacks of apathy and mental confusion. The pigment disappeared in about one month after the man had recovered from the attack.

4. *Toxæmic Pigmentation.*—Under this head I include the pigmentation which accompanies syphilis, tuberculosis, leprosy, diabetes, alcoholism, arsenical poisoning, Addison's disease, cancerous cachexia, and especially cancer of the abdominal organs. The histological character of the pigmented skin has been described by Brooke and Leslie Roberts.

5. *Neoplastic, or Pigmentation with Erratic Developments of the Germinal Layer.*—(1) *Nævi.* —Under this head I include all those embryonic anomalies which take the form of sharply circumscribed hard or soft wart-like tumours, and in which excess of melanin is a striking feature. It has been shown that the melanin is not confined to the epidermis, but may be found extensively in the cutis even to the deepest parts.

(2) *Xerodermia Pigmentosum* (Syn. *Kaposi's disease, Atrophoderma pigmentosum* (Crocker)). —This disease, which usually, but not always, begins in the earliest period of childhood, affects only the parts exposed to sunlight, namely, the face, neck, breast, forearms, and the backs of the hands. These parts become the seat of numerous freckle-like pigment spots. Even in a very early stage spots of capillary congestion with slight scaling can be seen. As the disease slowly advances, signs of degeneration starting in the epithelium and papillary body become more and more apparent. The skin becomes thinned and shrivelled, the lower eyelid may be drawn down, the orifices of the ears and mouth contracted. Red specks, consisting of dilated capillaries, are scattered all over the affected area, intermixed with dark freckles and pearly white spots. About the sixth or seventh year warty formations begin to appear in the pigmented epithelium, and slowly these are converted into fungating carcinomatous tumours. The prognosis is absolutely unfavourable. The extraordinary sensitiveness to actinic rays is not necessarily congenital, although usually so. I have seen the disease in a woman aged sixty-four in Kaposi's clinic in whom the affection began about sixty years of age.

(3) *Acanthosis Nigricans.* — Cases of this disease have been described by Unna, Janovsky, Pollitzer, C. Boeck, Collan, and others. The pigmentation affects several parts of the cutaneous surface, but more especially parts which are naturally inclined to pigmentation, *e.g.* the axillæ, neck, groins, genito-anal region, and abdomen. The deposit of melanin in the epithelium is followed by an enormous overgrowth of the prickle layer, imparting to the

pigmented areas a papillary, wart-like aspect. In Boeck's case the disease occurred in a woman, aged fifty-two, who had been operated on for non-relapsing cancer of the breast three years before. Death followed two years after the onset of the symptoms. Cases resembling in some respects A. nigricans have been described by Radcliffe Crocker and Leslie Roberts.

(4) *Melanotic Multiple Sarcomata.* — This neoplastic disease, originally supposed to be sarcomatous in nature, is called by Unna nævo-carcinoma, who maintains that the new growth arises in pigmented moles from the epithelium, and not from the mesoblastic tissues. This view is confirmed by the investigations of Gilchrist of Baltimore and Johnstone of New York.

(5) *Post-inflammatory Pigmentation.* — True hypertrophy of pigment may follow inflammatory diseases affecting the epithelium. The most striking of these is lichen planus, in which the pigmentation may be intense. It is to be noted that the pigment formation corresponds with the period of recovery and restoration of the epithelium. Pigmentation may follow erythema multiforme and urticaria. When pigmentation follows the cure of psoriasis it is probably due to the action of arsenic. The discolorations which follow eczema are usually of hæmic origin.

B. *Disappearance of the Melanin with Arrest of Pigment Function.* — (1) *Congenital.*—Albinism may be partial or complete. This abnormality is most frequently met with in the coloured races. The arrangement of the achromic patches is usually irregular. It may be unilateral, as in Hutchinson's case (*Archives of Surgery*, vol. i., 1889). Occasionally they are symmetrical. It is stated that complete albinoes are defective in powers of resistance. Darwin states that albino cats with pink eyes are usually deaf.

(2) *Leucodermia* (Syn. *Vitiligo*, *Melasmic leucopathia*, *White disease*). — When pigment matter has ceased to be precipitated, what already exists may be completely withdrawn. The laws relating to the disappearance of melanin are unknown. The final term of the process, whatever that may be, is atrophy, just as new and erratic growth is the final term of the melanin-forming process. Usually the process does not extend so far, and we have simple disappearance of pigment without any obvious structural change, and when once this pigmentless character is attained it seldom if ever reverts to the normal-coloured condition. The withdrawal of pigment from a circumscribed area is accompanied by increased formation in the immediate neighbourhood. Hence the fitness of the name employed by Laycock, namely, "melasmic leucopathia." The clinical result is a white patch surrounded by a pigmented margin. Numerous patches form on any part of the body. They spread slowly, and may remain stationary for years. Eventually the whole surface may be involved, and such cases are sometimes described as "cures." If the leucodermic patch is hairy, the pigment is withdrawn from the hairs, which thus become colourless. Leucodermia may occur in apparently healthy and normal skins. It is commoner in the tropics and among the coloured races. Laycock describes its concurrence with enlargement of the lymphatic glands, and in one case with general leucocytosis. The withdrawal of pigment always accompanies alopecia areata.

Pigmentary Anomalies of Hair

Laycock rightly regarded hair as an excretory organ for carbon pigment. In light-coloured hair the colouring matter is confined to the medullary cells, but in the dark brown and black varieties the pigment granules are to be found throughout the whole of the cortical substance, lying between the fibrous plates. The pigment is melanin, and, so far as we know, identical with that of the epithelium. Greyness or whiteness of the hair is natural in old age, but it may occur quite early in life as an hereditary peculiarity, or as a result of disease or long-continued bodily exhaustion. Many cases are recorded of the hair becoming suddenly grey, or even white, under the influence of terror or grief. The curious anomaly of grey hair becoming once more pigmented has been observed on rare occasions. Dr. Meachen records a case of a child in which the withdrawal of pigment occurred in rings at regular intervals, thus imparting a ringed appearance to the hair. The names ringed hair and leucotrichia annularis have been given to this condition. Changes in the colour of the hair have been observed to take place under the influence of pilocarpine. Borax may effect the colouring matter of hair in so far as it affects the growth of the hair papillæ. Cases recorded of changes of hair colour in workmen in copper-smelting works and cobalt mines are probably examples of spurious pigmentation.

Treatment of Abnormalities of Pigmentation. —As the pigment is situated in the deeper layers of the epidermis and rarely disappears spontaneously, the only remedy lies in complete destruction of the pigmented epidermis. In extensive distribution of pigment it would be inadvisable to attempt this; when limited to a few freckles, the method suggested by F. Hebra may be tried. Care must be exercised in the choice of a caustic, for, as Hebra says in his treatise, there are some caustics after the action of which the epidermis subsequently formed contains more pigment than that preceding it, and others, on the contrary, after the application of which the newly produced epidermis contains less pigment than that which was destroyed. To the first belong spurge-olive, croton oil, cantharides, mustard-seed, and sulphuric acid; to the latter, acetic, hydrochloric, and

nitric acids, borax, the caustic alkalies and their carbonates, and above all corrosive sublimate. The aqueous solution of the sublimate, 5 grains to the ounce, should be applied closely and evenly to the pigmented area and left *in situ*, being re-wetted from time to time, for three or four hours. When the compress is removed, some soothing paste or powder should be applied daily until the destroyed epidermis is removed and replaced by newly formed epithelium. It must be remembered that this treatment is only suitable for very limited patches; in cases of incurable chloasma it is advisable to inform the patients of the incurableness of their condition. This advice also applies to leucoderma, for which we have no remedy.

Spurious Pigmentations of the Skin

There are many cases in which parts of the skin are discoloured by pigments other than melanin, and these may be conveniently grouped together under the head of spurious pigmentations.

1. Parasitic diseases which produce discoloration of the surface—

(1) *Pityriasis versicolor* is a mycotic disease characterised by the formation of fawn-coloured or brownish scaly patches of irregular shape and size, chiefly met with on the chest, abdomen, and back, and occasionally on the limbs, and very rarely on the face and scalp. It gives rise to very little irritation, and is not accompanied by inflammatory symptoms. The fungus which produces this disease is *Microsporon furfur*, a mould of very low and imperfect type, which secretes a brown pigment. It produces mycelium and spores, which form little masses lying between the mycelial threads. Its mycelium vegetates in the horny layers, which it breaks off into fragments or scales, thus producing the condition known as pityriasis. The only disease likely to be confused with it is leucoderma, and as this diagnosis might lead to trouble, it is important for the practitioner to be familiar with the points of distinction. In leucoderma the cuticle is smooth and coherent, while in pityriasis it is scaly or readily crumbles under the finger-nail. The pigment ends abruptly in the parasitic disease, while in leucoderma it gradually fades into the surrounding skin. If any doubt exists, the microscope will settle it. Treatment consists in the vigorous use of soap and water, with the application of a lotion of hyposulphite of soda or perchloride of mercury.

(2) *Erythrasma* is a mycotic, superficial, inflammatory disease met with in the axilla, the inguinal, and genito-crural regions, and is characterised by the formation of rounded, scaly patches of a reddish brown tint. It is provoked by a mycelial fungus allied to the trichophyta, and called by Bärensprung Microsporon minutissimum.

(3) *Pinta*, or "spotted sickness." See vol. viii. p. 103.

(4) *Otomycosis aspergillina*. See vol. ii. p. 475.

2. *Chromidrosis and Seborrhœa Nigricans.*—Under certain conditions not yet understood the sweat and sebaceous secretions may be coloured. The pigments are unknown, but they are contained in the cutaneous secretion, and not in the tissues. The tints vary from red to blue or violet, blue being the commonest variety. The favourite locality is the face, especially the eyelids, but it may occur on any part of the body. The pigment in the sebaceous secretion may be black, yellow, or blue. Laycock has collected several cases of seborrhœa nigricans. It seems certain that these pigmentary anomalies are associated with emotional or other neurotic disturbances. They may coincide with hyperæsthesia of the skin in the pigmented area. The pigmentary conditions of the sweat which result from the growth of chromogenic bacteria, or those due to the presence of coloured salts of iron or copper, are to be regarded as purely accidental pigmentations.

3. *Mineral Pigmentation.*—(1) *Argyria* is the name given to the slaty blue discoloration of the skin produced by the prolonged administration of silver nitrate. It was more commonly met with in the days when silver nitrate was administered for epilepsy. It may follow the local application of the drug to the throat. Radcliffe Crocker records a case in which the blue discoloration did not appear till many years after the topical application had ceased. The colour is supposed to be due to the reduction of the silver salt in the epithelium.

(2) *Tattooing.*—In this barbaric operation gunpowder and red lead and other pigments are conveyed into the cutis by means of sharp-pointed instruments. We need not further consider it.

Skin Grafting and Allied Procedures

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The generic term *skin grafting* is applied to a series of surgical procedures, which, while they are all directed towards the same object, vary widely in their range of applicability and in their technical details.

The object in all cases is to bring about the rapid and sound healing of a raw or a granulating surface, in such a way as to produce a strong

and pliable cicatrix, which will subsequently undergo a minimum amount of contraction.

Natural Epidermisation of a Raw Surface.—The rapidity with which a raw surface is covered with epithelium by natural means depends on various factors, one of the most important of which is the depth to which the skin has been destroyed. As regeneration of the skin takes place from its middle and deep layers, when the destructive process has spared any portion of the rete Malpighi—as, for example, in a burn of the third degree—the surviving cells form islets of epithelium scattered over the surface of the sore, which by their increase in size materially help the marginal epithelium to form a protecting covering. Any of the lining cells of sebaceous glands, sweat glands, or hair follicles which have not been destroyed act in a similar manner. There is little doubt also that free epidermic cells from the surrounding skin, accidentally transferred to the raw surface—for example, in the serum of blisters, or in other ways—are also capable of starting healing centres on the surface of the sore.

Another important factor in determining the rapidity of healing is the capacity of the surrounding tissues to contract. Where the skin is firmly bound down to an underlying fascia or bone, or where the tissues are œdematous or indurated, healing is materially impeded by interference with contraction which is so necessary to repair by the process of granulation.

That a debilitated condition of the patient, or the presence of sepsis in the wound, retards healing goes without saying.

Sources of Grafts.—Skin grafts may be taken from the patient himself (*autoplastic grafts*); or from another person (*heteroplastic*); or they may be derived from one of the lower species (*zöo-plastic*). There is little doubt that the most satisfactory source is the patient himself. There is evidence that disease has been transmitted from one person to another through the medium of skin grafts; and a reasonable, although partly sentimental, objection may be raised to the use of grafts taken from the cadaver or from a recently amputated limb.

Grafts taken from the lower species have been extensively employed, a great variety of epithelial structures having been experimented with. Thus the lining membrane of the hen's egg, the skin of the frog, the inner surface of a pullet's wing, the skin of pups, kittens, pigs, rabbits, and guinea-pigs have all been used, but with few exceptions the results have been less satisfactory than those obtained by grafts taken from the human subject. It is generally recognised by those who have had experience of this method that the skin of *young* animals yields the best results, probably because of its great potential power of growth.

Terminology.—Inasmuch as the material used in the different skin-grafting processes, as well as the method of using it, varies considerably, it seems desirable to employ terms which are descriptive of the various procedures practised. Some surgeons have suggested the term *skin transportation* as applicable to such measures as involve the transference of the whole thickness of the skin from one part to another, reserving the term *skin grafting* for cases where something less than the whole thickness of the skin is used. Such a distinction cannot be maintained, because in the latter case it is merely epithelium which is employed, and in both the grafting process is effected by transportation.

A more accurate and practically useful nomenclature would be: (*a*) *Epithelium sowing* (methods of Sée, Lister); (*b*) *Epithelium grafting* (methods of Reverdin, Thiersch, Ollier, Lusk); (*c*) *Skin grafting* (methods of Krause, Wolff; and the method of grafting from the lower animals).

Cases Suitable.—Skin grafting is applicable to the treatment of all varieties of external ulcers, especially such as result from burns or scalds. After crushes, machinery accidents, or septic processes, involving wide destruction of the skin also, healing is greatly expedited by the use of skin grafts. The raw surfaces left after excising patches of lupus, epithelioma, or other forms of tumour implicating the skin may be at once covered by skin grafts. Similar measures are frequently employed in rectifying deformities, whether due to congenital defects, such as extroversion of the bladder, or to the results of injury or disease, as in ectropion, destruction of the nose or cheek, and mastoid fistulæ.

Suitable Surface.—Opinions vary as to the most suitable surface on which to place skin grafts. Some surgeons prefer a fresh raw surface made by the knife; others are content with a healthy layer of granulation tissue; while others employ the surface left after scraping away the superficial layer of granulations.

All are agreed, however, that the factors of primary importance are, that the surface shall be free of active septic organisms, that it shall have a good vascular supply, and that the tissues surrounding it shall be free of inflammation, œdema, or induration. In the case of a granulating surface, the marginal epithelium should show evidence of proliferation, in the form of a dry, reddish blue zone round the edge of the sore.

As the grafts maintain their vitality and power of reproduction by becoming vascularised from below, the surface which most readily facilitates the growth of young capillaries into them is theoretically the best. From its structure, direction of growth, and functional activity, a healthy granulating surface would

furnish the most suitable soil for the skin grafts were it not that it is seldom as free from septic organisms as is desirable. Another objection to grafting on a granulating surface lies in the fact that cicatricial contraction is a necessary sequel to this form of tissue repair, whereas comparatively little shrinkage follows when grafts are implanted directly on to a fresh raw surface.

The ultimate mobility of the new covering also depends to a large extent on the nature of the surface on which the grafts are placed. The more elastic tissue there is developed in the new skin the greater is its mobility; and as no elastic tissue forms in granulation tissue, it does not constitute a suitable soil from this point of view. Elastic tissue in a scar is entirely derived from the underlying and surrounding healthy tissues, but it is to be borne in mind that is naturally more abundant in some situations than in others. The mobility of the new skin also depends on the plasticity of the surrounding tissues and the original extent of the gap covered in.

As a matter of practice, it is found that, given an aseptic and fairly vascular surface in a patient of moderate vitality, it is of comparatively little importance, so far as the survival of the grafts is concerned, which kind of surface is selected. The best ultimate results, however, are obtained by grafting on a fresh raw surface. Each case must therefore be decided on its own merits, having consideration to the patient's power of standing such procedures as the excision or scraping of the ulcer, with the attendant loss of blood, and the nature of the cicatrix it is desirable to obtain.

Preparation of the Surface.—(*a*) *A fresh raw surface*, such as results after the excision of a tumour of the skin, or the paring of tissues in plastic operations for the rectification of deformities, requires no further preparation than is necessary to ensure its asepticity and to arrest hæmorrhage. The former indication is met by the use of a moderately strong antiseptic wash,—such as 1 in 60 carbolic, 1 in 2000 corrosive sublimate, or 1 in 200 lysol,—followed by free douching with normal salt solution; and the latter by torsion or forcipressure of the visible vessels, and firm pressure with a pad of sterilised gauze for capillary oozing. Ligatures should, if possible, be avoided as, being foreign bodies, they interfere with accurate apposition between the graft and the surface to which it is applied. (*b*) In the case of *chronic ulcers*, such as occur on the legs in association with varicose veins and other conditions, it has been found advantageous to excise the ulcer entirely, including its indurated edges and a zone about half an inch wide all round. The base of the ulcer is dissected up, so as to expose healthy vascular tissue beneath it, and the dense layer of fibrous tissue which in cases of old standing underlies the granulations is removed. To prevent the granulations infecting the raw surface during removal, the writer has been in the habit of painting the surface of the ulcer with pure carbolic acid for a day or two before the operation. This procedure is but slightly painful, and has been found efficacious in eliminating sepsis. To arrest oozing after excision of the ulcer, a pad of sterilised gauze saturated with peroxide of hydrogen (10 volumes strength) is applied all over the raw surface. This application has the further advantage that it is a powerful and penetrating, although non-destructive, antiseptic. After the bleeding has ceased, the excess of peroxide solution is washed away by a copious yet gentle stream of tepid saline fluid.

(*c*) *In ulcers resulting from burns*, especially when extensive and of comparatively recent date, it is not necessary to excise the whole ulcer. After thorough purification of the granulating surface and the surrounding tissues, the superficial layer of granulations is scraped away with a sharp spoon, the young fibrous tissue underneath being conserved, as it is still sufficiently vascular to afford the necessary supply to the grafts placed over it. Any young epithelium which may have formed round the margin of the ulcer should also be removed, as it is very liable to break down after the grafts have united and leave a raw ring around the newly formed cicatrix. Oozing is stopped by the use of peroxide of hydrogen or by firm pressure with a pad of sterilised gauze, a layer oiled-silk protective being interposed to prevent the gauze sticking into the surface and starting bleeding again when it is removed.

While it is most important to render the surface on which grafts are to be placed thoroughly aseptic, it is undesirable just before the operation to employ strong chemicals for this purpose, as these induce a copious oozing of serum which tends to prevent accurate apposition of the grafts. Whatever antiseptics are used, the surface should be freely douched with normal salt solution before the grafts are applied.

Preparation of Surface which yields the Grafts.—The surface from which the grafts are to be taken should be prepared in the same way as for any other aseptic surgical operation, by thorough washing with soap and water, soaking for twelve hours with a 1 in 40 carbolic compress, and finally washing, just before the operation, with lysol, corrosive, or other antiseptic.

Methods of Grafting

Epithelium sowing—the simplest of all these procedures — has been variously ascribed to M. Sée and Lord Lister. It consists in scraping with a knife-edge the superficial epithelial cells from some part previously purified—

such as the arm, hand, or sole of the foot—and scattering them indiscriminately over the surface of the ulcer. A certain number of the cells take root and grow, and so help the healing process. They also act in some mysterious way—as all forms of skin drafts do—in stimulating the growth of the epithelium at the margin of the sore. The cicatrix thus formed, however, is found to be weak, and very liable to break down again. In view of the much more satisfactory results obtained by processes no more difficult to carry out, this method is but seldom employed and is not to be recommended.

Epithelium Grafting. — *Reverdin*, in 1869, first suggested and practised the planting of minute fragments of vital epithelium with a view to hastening the healing of granulating surfaces. The results were so satisfactory that the method soon became an established procedure in plastic surgery. A portion of the patient's skin, previously purified, is raised with the point of a needle, and a small piece about the size of a split pea removed with a razor or with scissors curved on the flat. The graft consists only of the epidermis and superficial layer of the rete mucosum, and should be cut without drawing blood. The skin of the prepuce removed by circumcision from a healthy child furnishes most useful material for this method of grafting. The portion of skin is cut into small fragments, each about the size of a pin's head, and these are planted over the surface of the ulcer. As each of these fragments has only a potential growth of about half an inch in diameter, it is advisable to place them so that the edges of the epithelial islets which form will touch one another, and to plant them near the edge of the ulcer in order that the grafted epithelium may blend with that of the margin, and so consolidate the cicatrix. If the grafts are widely scattered all over the granulating surface, so that the circular islets which result from their growth are unsupported by one another and by the marginal epithelium, they are very liable to disappear again, being destroyed by the granulations which grow up between them. When sufficient material is not available to plant out the whole raw surface, it is better to confine operations to one portion of the ulcer at a time.

The *dressing* applied consists of imbricated pieces of oiled-silk protective or silver foil, covered over with a pad of moist aseptic gauze and absorbent wadding, retained in position by a firm bandage. A splint or other retentive apparatus is useful in preventing movement of the part and disturbance of the grafts.

The dressing is changed in four or five days. It is often found that many of the grafts have disappeared, but this does not necessarily mean failure, as they reappear a few days later as thin, bluish, glazed areas, which rapidly increase in size and thickness.

The healing of the ulcer is markedly accelerated by this procedure, but it must be admitted that the resulting cicatrix is somewhat weak and liable to break down, and that there is considerable tendency for it subsequently to contract.

Lusk, of New York, has employed the epidermis raised by blistering for purposes of grafting. After purifying an area of the patient's own body, slightly larger than the size of the ulcer to be covered, blistering fluid is painted over it. When the blister rises, the fluid is let out, and the raised cuticle carefully cut off with scissors and transferred to the granulating surface.

Similar material may often be obtained from cases of accidental burns or scalds, or by paring with a razor the surface of callosities on the sole of the foot, after thorough purification with carbolic lotion.

Lusk has found that such material may be sterilised between glass plates in an ordinary surgical steriliser, and that after being dried it will keep for an indefinite period, and on being applied to an ulcer acts as efficiently as a recent graft.

Over the grafts he applies a dressing of sterilised gauze, saturated with balsam of Peru (one drachm to the ounce), and sterilised absorbent wool. This dressing is not changed for ten or fifteen days.

Thiersch's Method.—The general concensus of opinion seems to be that the most generally satisfactory results are obtained by employing grafts cut in long strips, and containing half the thickness of the skin—the method associated with the name of Thiersch of Leipsig.

Although Ollier of Lyons had previously suggested the principle involved in this procedure, the credit of bringing forward the practice and demonstrating its value undoubtedly belongs to Thiersch.

The most convenient source of Thiersch grafts is the inner aspect of the patient's own thigh or upper arm, or, when these are not available, the front of the forearm, the skin in these situations being soft, pliable, and comparatively hairless. When more hairy parts are selected, they should be shaved before the grafts are cut. The area which is to furnish the grafts should be purified beforehand in the same way as any other part on which an aseptic operation is to be performed. Hirschberg believes that the grafts are more likely to grow if the skin from which they are taken is rendered hyperæmic before cutting them. Fischer, on the other hand, has obtained his best results after producing an artificial ischæmia.

The surface to be grafted is prepared in one or other of the ways already described, and the bleeding completely arrested before the grafts are placed in position.

For *cutting the grafts*, a sharp, hollow-ground

razor is employed, the blade being moistened by hot saline solution. To cut long, even, and uniformly thick grafts, considerable art is required, which can only be acquired by practice. The essentials to success are (1) that the razor shall be sharp and moist; (2) that the skin be kept perfectly flat and perfectly steady, which is ensured by an assistant stretching at one end of the area operated upon, while the surgeon with his left hand stretches and steadies the other end; and (3) that the razor be used with a rapid, short, sawing movement. By attending to these points, strips of epithelium six or eight inches long by one and a half to two inches wide can readily be cut. The grafts should be immediately transferred to the surface on which they are to be planted. It is not usually necessary to irrigate while cutting the grafts, nor to transfer them to hot boracic lotion before placing them in position, as has been recommended by some.

The grafts are placed on the sore, deep surface downwards, edge to edge, or, better still, slightly overlapping one another at their margins, so that they form a complete carpet to the sore. After they have been spread out, firm pressure is made over the grafts with a pad of sterilised gauze wrung out of normal salt solution, to express any blood or air-bubbles which may have collected under them. To prevent the grafts adhering to the gauze, a sheet of perforated oil-silk protective should be interposed.

Dressing.—When the grafts are applied to a fresh, raw surface, and when there is no reason to anticipate any discharge, a dry, aseptic gauze dressing may be applied. When the grafts are applied to a granulating surface, on the other hand, and when there may be doubt as to its perfect asepticity, a protective dressing should be employed.

This dressing consists of imbricated pieces of protective covered by antiseptic or sterilised gauze, and a thick layer of absorbent wool secured by a firm bandage. A retentive splint or other apparatus is of great advantage in preventing movement.

The *raw surface left by the removal of the grafts* is bathed with a mild antiseptic and covered with a dry gauze dressing. The writer has found a simple picric acid dressing, such as is used for burns, answer admirably. It need not be disturbed for ten days or a fortnight, by which time everything has healed.

Subsequent Dressing.—When a dry dressing has been employed, it may be left in position for from seven to ten days. When protective has been used, the grafted area should be dressed on the fourth, fifth, or sixth day, the utmost gentleness and care being exercised to avoid displacement of the grafts. Grafts which have taken present a smooth, dry, pink surface, in contrast to the soft sodden, dirty grey appearance of such as have failed. At the next dressing, say three or four days later, it may be found that the epidermis of the grafts peels off as a fine, grey pellicle, without, however, affecting the vitality of the graft, which by this time is firmly adherent. A simple ointment dressing—such as weak boracic ointment (a quarter of the pharmacopeal strength)—is applied until consolidation of the new covering takes place.

In the case of leg ulcers treated in this way, a prolonged period of rest in the recumbent position is necessary to allow of the consolidation of the cicatrix. There is considerable risk of the grafts breaking down if the limb is allowed to hang for any length of time within three months of the operation, and in cases of old-standing ulcer, even a longer period of recumbency should be recommended. Great difficulty is often experienced in persuading patients of the importance of this part of the treatment. On other parts of the body confinement to bed need not be protracted beyond six or eight weeks, but great care must be taken to avoid active use of a limb for some weeks longer.

Skin Grafting.—The transplanting of portions of the whole thickness of the skin was first systematically practised by Wolff of Glasgow, who employed it to repair defects of the eyelids. He carefully avoided removing any portion of the subcutaneous fat with the grafts.

Krause of Altona has recently (1896) revived interest in this method. He too avoids the subcutaneous fat. The grafts are placed upon a recent fresh surface, and if granulations have already formed, they must be scraped away and the surrounding surface pared with a knife until fairly healthy tissue is reached. These grafts have taken equally well when planted on muscle, fascia, connective tissue, periosteum, or even on denuded bone.

The source of the grafts is prepared as for an aseptic operation, and to enable the wound made by their removal to be closed; oval or spindle-shaped grafts should be cut.

When it is desired to cover over a raw surface with a single graft, it must be borne in mind in planning the operation that the skin shrinks after separation to about two-thirds of its original size. It is seldom necessary to stitch the grafts in place, except upon the face.

The first dressing should be performed on the third or fourth day, as vesicles are apt to form on the transplanted skin. It is necessary to take great care not to disturb the feeble attachments which the grafts have formed with the wound. The after-treatment is the same as in Thiersch grafting.

The epidermis peels off in a week or ten days, and occasionally small superficial areas of necrosis form. Complete healing takes from

three to six weeks. The new skin eventually becomes movable by the development of subcutaneous fat, but it is long ere sensibility is established.

Grafts taken from the Lower Animals.—As has already been said, many attempts have been made to utilise the skin of the lower animals to cover in defects on the surface of the human body. The most satisfactory results have been obtained by using the skin of young, warm-blooded animals, such as pups, kittens, rats, and guinea-pigs.

The ulcer is prepared in the same way as for grafting by Krause's method, and the whole thickness of the skin is employed, that from the anterior abdominal wall being the most suitable. After killing the animal the skin is shaved, and dissected up without the subcutaneous fat. In other respects the procedure is the same as in transplanting the whole thickness of the human skin.

Histological Changes.—The anatomical and histological changes associated with the growth and consolidation of grafted skin have been most thoroughly studied in relation to Thiersch grafts. When such grafts have been placed on a raw surface without the intervention of granulation tissue, in the course of a few weeks the new skin is found to be slightly reddened in comparison with the normal skin, as a result of the formation of new blood-vessels in the substance of the graft. The original blood-vessels of the grafted tissue are found to degenerate, and to be replaced by new vessels growing up from below. These finally vascularise the papillæ and so complete the blood-supply of the skin, a process which occupies several months.

The superficial epidermis of the graft is shed as a fine pellicle within a few days of transplantation, but is soon replaced by a covering of laminated scales, which are shed more rapidly than in normal skin, on account of the increased nutritive activity of the grafts. The more vascular the transported tissue is the thicker is the epithelial covering, and the less tendency is there to excessive desquamation. As the graft becomes vascularised it gradually reaches the level of the surrounding skin, and as it contains no fibrous cicatricial tissue it soon becomes freely movable on its bed, and shows little or no tendency to cicatricial contraction. Normal tactile and thermal sensibility gradually returns in the course of a few months, progressing from the periphery of the graft towards its centre. As a rule, the hair-follicles and secreting glands of the skin are not reproduced in the grafts.

Transplantation of Mucous Membrane.—Successful attempts have been made to cover over defects in various mucous surfaces, such as the conjunctiva, the cheek, and the urethra, with grafts of mucous membrane taken from man or from the lower animals. The technique is similar to that employed in skin grafting.

Skoda's Sign, or Skodaic Resonance. *See* Pleura, Diseases of (*Acute Pleurisy, Effusion, Percussion*).

Skull. *See* Achondroplasia; Acromegaly; Bone, Diseases of; Brain, Physiology of; Brain, Hypertrophy; Brain, Surgery of; Children, Clinical Examination of (*The Head*); Ear, Middle, Chronic Suppuration (*Caries and Necrosis*); Ear, Middle, Chronic Suppuration (*Disease of Mastoid Process*); Facial Hemiatrophy; Head; Headache; Hydrocephalus; Hypertrophy (*Unilateral Hyperostosis of Face*); Insanity, Pathology of (*Pathological Anatomy*); Leontiasis Ossea; Meninges of the Cerebrum (*Inflammation of the Dura Mater*); Meninges of the Cerebrum (*Tumours*); Mental Deficiency; Mouth, Injuries and Diseases of the Jaw; Nose; Orbit, Diseases of; Palate; Physiognomy and Expression; Post-mortem Methods (*Head*); Rickets; Syphilis; Teeth.

Skutsch's Pelvimeter.—A somewhat complicated apparatus for measuring the conjugata vera and the transverse diameter at the brim of the maternal pelvis in or before labour; it is somewhat difficult of application, but gives fairly accurate results.

Slaughter-Houses. *See* Abattoirs.

Slavering.—The flowing or dribbling of saliva from the mouth, as in many cases of insanity, during dentition, and in some abnormal pregnancies.

Sleep, Normal and Morbid.

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See also Anæsthesia; Hypnotism; Hysteria (*Convulsions, Varieties, Fits of Sleep*); Hysteria in Childhood (*Symptoms*); Insanity, Pathology of (*Condition of Brain Cells during Sleep*); Morphinomania and Allied Drug Habits (*Effects*); Nose, Post-Nasal Adenoids (*Symptoms, Sleep-walking*); Nursery Hygiene (*Sleep*); Physiology, Nervous System (*Cerebrum, Sleep*); Physiology, Respiration (*Sleep, Hibernation*); Sleeping Sickness.

Physiology.—The physiological basis of sleep is a matter of uncertainty. Its phenomena are of the deepest interest, and when we consider the relationship of sleep to all forms of animate existence we wonder how it is so comparatively

few workers have devoted their attention to its study. Our knowledge of the conditions of sleep, both normal and morbid, and their relationship to different diseases, is still extremely meagre. Most writers have devoted their attention to the interpretation of dreams and allied phenomena, and in the immense mass of literature now available there appears to be a tendency to attach to these phenomena a prophetic and miraculous significance rather than a rational and physiological explanation.

Normal Sleep.—Various alterations in the organic functions occur during sleep. Respiration becomes slower, and the amount of inspired air diminished. In man, costal respiration predominates. The elimination of carbonic acid is diminished and absorption of oxygen increased. All alcoholic drinks, tea, and the ethereal oils considerably diminish the elimination of carbonic acid, and probably increase the absorption of oxygen (Vierordt). The ingestion of food has also some relation to the gaseous exchange in our bodies during sleep.

Cardiac action is slower and less energetic, blood pressure falls, and the peripheral vessels dilate. The pulse may slacken or become accelerated. The temperature usually falls. Enlargement of the limbs occurs, the increased volume being due to the venous engorgement arising in consequence of relaxation of the cutaneous vessels. The sweat glands of the skin act more freely during sleep, hence the greater liability to chills than when awake. The internal organs are usually somewhat anæmic, and at night-time their functions are more or less enfeebled. The observations of Busch (Virchow's *Archiv*, 1858, Bd. xiv.) seem to demonstrate that in sleep during the day the bodily functions continue, and the stomach, etc., are active. At night-time, however, their activity is diminished. Hence it is that nocturnal employments are antiphysiological, and the bodily economy and metabolism can only be adjusted with great difficulty. The kidneys usually remain active during sleep, or if they are less active it is due to greater activity of the skin. With sleeplessness the circulation becomes accelerated and the blood impoverished owing to the diminution of the number of red blood corpuscles. The nervous system undergoes certain modifications during sleep. The knee-jerks become less active or may disappear entirely during deep sleep; but when there are intercurrent cerebral activities going on, as manifested in hypnagogic and dream states, they may become more active. Rosenbach (*Zeitschrift f. klinische Med.*, 1881, Bd. Heft 2) observed the reflexes excited in children by tickling the palm of the hand, the sole of the foot, and occasionally other parts of the body; also the cremasteric abdominal and tendon reflexes and the pupil reaction. At bedtime, and when sleepy, reflex excitability increases — a stage of restlessness comparable to the convulsive stage of chloroform narcosis. During the first period of sleep, and while it is still light, there is weakening of reflexes and commencing contraction of pupil; in the second or deeper period, abdominal, cremasteric, and tendon reflexes are abolished; in deepest sleep, tickling the sole of the foot, the nose, or ear still causes reflex movement (Marie de Manacéine, *Sleep: its Physiology, Pathology, etc.*, p. 25).

It is generally supposed that the brain becomes anæmic during sleep, and the interesting observations of Tarchanoff, Wedensky, Waller, Bowditch, Despine, Moreau, and others seem to demonstrate that during sleep, although the cortex cerebri ceases to react consciously to various stimuli, nevertheless the stimuli are transmitted as if the sensory nerves were in full activity. The numerous examples of appropriate reactions to certain stimuli performed during sleep lead us to believe that the reflex arc is functionally active and awake and independent of consciousness. From the fact that stimulation of the optic, olfactory, auditory, gustatory, and cutaneous sensory nerves is attended by appropriate reactions, it is also assumed that the cerebral centres concerned with the reflex mechanism may also be awake during sleep. Possibly in dreams the activities existing in the centres may give rise to excitations or images which are consciously perceived.

The Theories of Sleep.—It is impossible here to consider all the various theories as to the causation of sleep. It has been attributed to the action of this or that organ, such as the thyroid gland (Forneris), the arachnoid plexus (Osborne), the basal ganglia (Purkinje); to cerebral anæmia (vaso-motor theory); to accumulation of lymph in the lymphatic spaces round the cerebral vessels; to chemical changes in the brain-cells or neurons—such as an exhaustion of their intramolecular oxygen, or an accumulation of the products of excessive metabolism in the form of leucomaines or poisonous alkaloids. The accumulation of these waste products of metabolism produces fatigue and sleep, and during sleep the process of oxidation aids the removal of the waste products. Too protracted mental strain or insomnia results in failure to completely remove or oxidise the toxic products, and instead of narcosis, excitement or even convulsions are apt to supervene.

The Depth of Sleep.—Hughlings Jackson has likened dreaming to insanity. He suggests several degrees of the normal dissolution of sleep: (1) Sleepiness, (2) sleep with dreaming, (3) sleep with actions (somnambulism), and (4) deep so-called dreamless slumber. He thinks at least (2), (3), and (4) ought to be considered as different depths of dissolution of the highest cerebral centres, with, (2) and (3) and possibly in (4), lower ranges of evolution remaining in those centres.

In the first stage of sleep it may be assumed that the physical basis of consciousness is affected, *i.e.* the highest level of evolution is for the time being quiescent. The actual cerebral locality or localities affected are not yet determined. The most we can assume is that the most highly evolved substratum of consciousness of the left hemisphere probably inhibits the right, and when the inhibition of the left is withdrawn the right is more free to act automatically.

Just as with the problems of so-called "double consciousness," until we have a more rational conception of what constitutes the actual physical basis of consciousness we cannot elucidate the true nature of sleep.

The amœboid theory enunciated more particularly by Ruckhardt, and elaborated by Lepine, Golgi, Ramon y Cajal, Duval, and confirmed by Lugaro, transfers the activities in the physical basis of consciousness to the neuroglia. It is supposed that the pseudopods of the neuroglia are possessed of the properties of extending and contracting. When extension or relaxation occurs the pseudopods intervene between the cells and their protoplasmic processes and the nerve-branches, so that the passage of nerve-currents is either entirely stopped or considerably impeded; the amœboid movements of the neuroglia thus acting as the isolators of the nervous currents. The neuron theory that every nerve-cell with all its parts is anatomically distinct from every other nerve-cell is borne out by the observed facts as to the trophic individuality of each nerve-cell, and it is probably true that each cell lives and dies a unit. The question as to whether the neurons are generically and structurally discrete, or whether the distributing processes of one neuron form true anastomoses with the collecting processes of other neurons, is too extensive to be discussed here. There is much to be said in favour of both sides of the question. The hypothesis that the ramifications (or pseudopods) of the cells do elongate and retract under varying influences, thereby favouring or breaking the contiguity of neighbouring neurons, and so rendering it possible or impossible for currents to pass, if true, would serve to simplify the explanation of consciousness and allied states.

I have elsewhere ("Double Consciousness," vide *British Medical Journal*, 23rd September 1899) stated that I regard the highest evolved centres as being a huge *congeries* of units or groups of units functionally continuous—under certain conditions of contiguity—with the periphery and with each other. These units may be compared to lamps which give light when their respective electric phenomena are in operation. Provided that the switches and transmitting agents, both peripheral and central, are functionally operative, they light up in turn in response to the stimulus, be it peripheral or central. The study of seriality of thought would appear to require some physical basis on this plan, and each element of conception would require some physical counterpart correlative to the light (derived from the analogy of the lamp). Carrying the hypothesis further, just as the switches, couplings, or currents may under one series of conditions become functionally inert at one time, leading to inability to produce light in one or several sets of lamps, so under another series of conditions may the same switches, couplings, or currents again become functionally active and determine the existence of light.

The physical elements correlative to the series of central lights constitute conception and seriality of thought, and the inertness of any of the physical correlatives of this seriality would result in a loss of some of the elements which go to make up consciousness and consciousness of self.

In sleep the physical basis of communication between full consciousness and the outside world in some way is disrupted or rendered functionally discontinuous. There may, nevertheless, be some consciousness derived from activities occurring within the organic substratum of consciousness, and there may also be perfect or even accentuated conduction of sensory stimuli from the periphery of the sensorium to be followed by elaborate and appropriate reactions as seen in automatic and somnambulistic states. Psychologically speaking, it is the diminished conscious recognition of the relationship of sensory stimuli to self and of self to the environment that characterises the first stage of sleep.

In the second stage the conscious perception of stimuli derived from without (exoneurally), or from within (esoneurally), is further diminished, and there is almost complete failure to recognise the relationship of self to the true in environment. The cerebral areas representing the various sensory and motor activities may remain active without bringing into complete activity the physical basis concerned with the factors involved in determining consciousness of environment. This second stage has been termed the hypnagogic stage, or the stage of dreaming and allied states.

The various hallucinations, night-terrors, somnambulistic and abnormal emotional states, signify that activities are going on in what remains intact of the highest centres. In the Jacksonian view, the positive mental states (as evidenced in these activities) imply the co-existence of negative mental states (as evidenced in non-recognition of the relationship of self to the true environment).

Owing to the fact that various nervous tracts do remain open, as it were, for the transmission of stimuli, it has been found possible to measure the depths of sleep. The method of investiga-

tion has been to determine the intensity of stimulus required at various periods of sleep to arouse the individual to consciousness of the stimulus and of self to environment.

Most observers agree that the depth of normal sleep increases during the first and second hour, after which it begins to decrease, then is again increased and maintained at about the same level. A typical sleep chart would be somewhat as follows:—

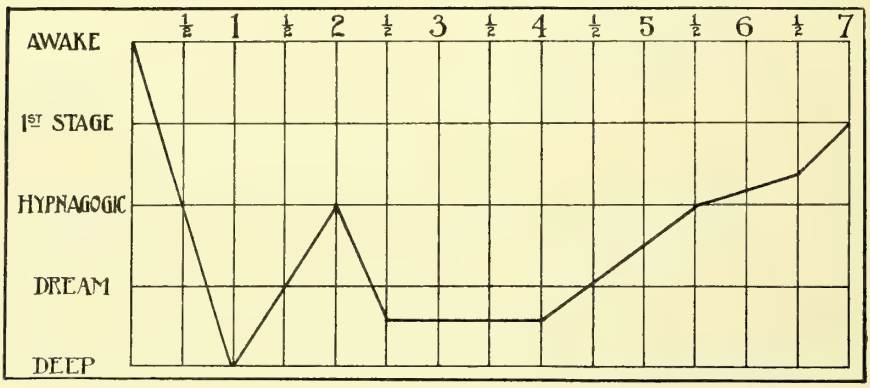


CHART 1.—Sleep tested at intervals of half an hour.

SLEEPLESSNESS.—The necessity for sleep is evidenced in those who are confined in our asylums, and it is sufficient to state that 90 per cent of the cases admitted to Bethlem Hospital since the year 1820 have suffered from insomnia.

There is no more common cause of brain exhaustion and insanity than insomnia, and the effects of prolonged sleeplessness are so injurious as to cause much serious care and study in nearly every case. The "repose of consciousness" is absolutely necessary for the metabolism and nutrition of the brain in order that the effects of the expenditure of energy during the waking hours may be counteracted and overcome. We have already seen that sleep does not necessarily arrest all cerebral activity; but it ought at least to arrest those activities which subserve the highest of our mental faculties, viz. self-consciousness.

Insomnia occurs in varying degrees of severity. Some individuals—especially those of neurotic temperament—sleep lightly and are awakened at the slightest stimulus; others again sleep profoundly, or the sleep may be protracted unduly. Perhaps there is no more definite sign of an unstable nervous inheritance than the occurrence of insomnia from slight causes. Overstrain either at physical or mental work, extreme heat or cold, intense joy or anxiety, suspense or the reaction which follows its alleviation, all these may be factors in inducing insomnia. In neurasthenics and hysterical subjects sleep may be fitful and uncertain. Physical pain also causes sleeplessness.

In considering the various defects of sleep, we have to note not only the defect itself so far as duration is concerned, but also the character and stages of sleep affected. Thus some individuals have a defective or prolonged first stage, as seen in the brain-worker, or the individual who has undergone some emotional or mental strain. He sinks but slowly into the deeper stages, which may be prolonged, and from which he can only with difficulty be aroused. Chart 2 is a typical chart of such a sleep. The experiment was conducted on a person who had worked for fourteen hours at the composition of an article for publication.

Another type is noticeable in those who have undergone great emotional stress or strain, and also not infrequently after dietetic errors or excesses. The first stages are rapidly passed through, but after a few hours there is a return to the hypnagogic or dream level, which is protracted until a secondary profound sleep is reached. This type is also common in infancy,

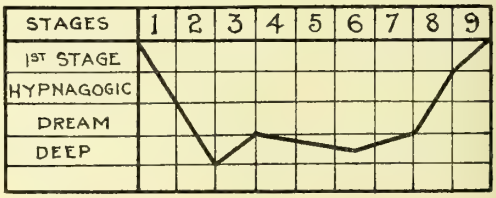


CHART 2.

and may be the result of reflex irritability induced by irritation of the gastro-intestinal canal.

The next type is one quite characteristic of nervous, hghly strung individuals. Sleep is

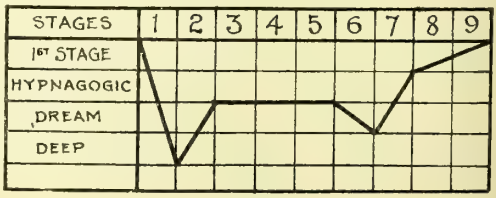


CHART 3.

readily induced, but there is a comparatively rapid rebound to the higher stages of dreaming and even partial consciousness.

The last type is that of excessive depth or morbid somnolence, where the individual rapidly

passes into deep slumber, and remains so until he is with difficulty awakened.

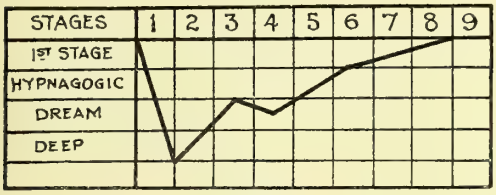


CHART 4.

MORBID SOMNOLENCE. — Morbid somnolence occurs as the result of habit, and in those who are anæmic, and also very commonly in children, savages, and cretins. Extreme heat and extreme cold also cause weakening of consciousness and morbid somnolence. *Narcolepsy*, or sleeping sickness, occurs in various countries as an endemic disease. It is more commonly seen in feeble-minded individuals, who after fatigue become drowsy, and pass into a condition of profound sleep, which may last, with or without intermissions, until death occurs. Sometimes the condition simulates that of katalepsy. In myxœdematous conditions there is apathy and increasing drowsiness, with weakening of all the mental faculties. In states of mental enfeeblement and of limited intellect there is a tendency to prolong the duration of sleep. In some of the reported instances of prolonged sleep there is some resemblance to the winter sleep of animals.

Clinically, the occurrence of fleeting interruptions of consciousness is of great importance. There are several types which should be mentioned. *Petit mal*, or paroxysmal sleep, occurring as a minor form of epilepsy. This condition ranges in severity from simple drowsiness or actual sleep to states of mental automatism in its different degrees. I have elsewhere (*Mental Physiology*, p. 342) mentioned the two chief hypotheses to account for the period of mental automatism, viz. (1) the period is not accompanied by consciousness, so that nothing can be recalled to memory; (2) consciousness does exist, but in so weak a form that none of the facts occurring in consciousness can be recalled. Certain cases of mental automatism are very closely allied to dream states, in which a person may answer questions rationally, having, however, little or no after-consciousness of the event. The loss of memory for dreams has been thought to rest in the fact that the states of consciousness during dreams are extremely weak.

The various types of so-called double consciousness form an interesting series of gradations between sleep and health. In a contribution to the proceedings of the British Medical Association (vide *British Medical Journal*, 23rd September 1899), I endeavoured to bridge the apparently impassable gulf between the phenomena of double consciousness and our more ordinary experiences, and drew analogies from a comparison with dream, somnambulistic, epileptic, amnesic, and insane states. Briefly enumerated, the cases mentioned fall under the following seven types :—

1. Those occurring in early life, and in which the abnormal state is preceded by night-terrors, somnambulism, or by both.
2. Types in which the abnormal state is preceded by profound sleep, and in which the normal state is only again reached after prolonged sleep.
3. Types due to temporary or periodic amnesia acquired as the result of accident, injury, or disease.
4. Epileptiform types.
5. Insane types.
6. Hysterical anæsthetic types.
7. Types in which, during the abnormal state, the subject assumes the possession of a mediumship.

These types are more fully considered in other volumes under the headings of "Night Terrors," "Memory," "Epilepsy," and "Unconsciousness."

Usually the narcoleptic types of morbid sleep tend to progress in frequency and severity until they threaten not only dementia—or loss of mental life—but also physical death.

Sometimes electricity has proved beneficial, but in the great majority of cases treatment seems to be of little avail.

Morbid somnolence occurs occasionally in the condition known as *katatonia*. The later stages of this disease (*attonita*) are characterised by immobility, with even marked rigidity of the muscles, and occasionally mutism. The motor inhibition is very noticeable, and the fixity of the posture, together with total inability to respond to stimuli, suggest a condition closely analogous to morbid sleep. Sometimes there is "verbigeration" or abnormal and uncontrollable repetition of words somewhat analogous to the phenomena called *echolalie*.

In this latter condition the subject may not understand or be able to answer any questions; he hears, but only repeats mechanically over and over again, at each repetition cutting the phrase shorter and omitting final syllables, until the whole has disappeared ("Sleep," in *De Manacéine*, p. 110). For particulars as to the relationship of sleep to hypnosis, *see* article on "HYPNOTISM."

THE HYPNAGOGIC STATE. — The condition known as the hypnagogic state occurs when the individual is neither awake nor fully asleep. During this period, as we have seen, the senses become more or less inactive, the activity of the sense of hearing being the most persistent. The reflex activity of the spinal cord is at first somewhat exalted, owing to its being released in a considerable measure from the control of the

brain. Psychologically speaking, as the sensory organs retire from action, the intellectual faculties lose their equilibrium. First the power of volition ceases, then the logical association of ideas comes to an end, the reasoning faculty disappears, and judgment is suspended.

During sleep, when the subject-matter supplied for the exercise of the faculties of perception and judgment, and the operations of the will, are withdrawn, the ideas that still arise are chiefly dependent for their origin and association upon the automatic and endogenous activities of the brain. Undisturbed by impulses from the external world, the brain seems then to become more sensitive to impressions having their origin within the body. In a condition of deep sleep due to exhaustion, or the influence of hypnotics, where the return to consciousness is comparatively sudden, hypnagogic illusions and hallucinations seldom occur. This is also frequently the case in persons with uric acid diathesis who recover consciousness through a comparatively short period of extreme drowsiness.

In infancy the occurrence of an overloaded stomach, or irritation of the gastro-intestinal tract due to some indiscretion of diet, readily induces dreams, and in some instances terrifying hallucinations. It is in the nervous individual, however, that the vagaries of memory and of imagination give those disorderly pictures during the prolonged stage of imperfect sleep. This may be further enhanced by an enfeebled heart, an irritable or turgid sexual apparatus, or by an irritable nervous ganglion. As the result of a terrifying hallucination, the individual may, during partial consciousness, commit crimes in self-defence.

Sometimes the sensory perversions are mainly illusory, and it has often been demonstrated that dreams may be suggested to the sleeper by stimulation of the special senses. Thus, on hearing the rustling of a newspaper an individual has dreamt of the sounds of waves on the seashore, and conjured up with vivid intensity the visual picture of its accompaniments.

The impressions produced by the dream may be so vivid that a belief in its reality may exist even some time after waking. Taine (*On Intelligence*, p. 61) mentions that Baillarger dreamed one night that a certain person had been appointed editor of a newspaper; in the morning he believed it to be true and mentioned it to several persons. The effect of the dream persisted all the forenoon as strongly as that of a real sensation; at last, about three o'clock, as he was stepping into his carriage, the illusion passed off and he knew that he had been dreaming. The instances where some bodily sensation forms the stimulus to set up an illusion are innumerable. Gaudin on one occasion read himself to sleep over an account of the race between the *Valkyrie* and the *Defender*. While in the hypnagogic state he imagined that he had one foot on each boat, and that as they passed each other he suffered some discomfort. On awakening he found his ankles tender, swollen, and temperature 103°.

I have elsewhere (*Mental Physiology*, p. 288) pointed out the similarity between the phenomena of dreams and those of insanity. Many of these phenomena are identical in every respect. There is in both a partial displacement of the *ego*, by which the "I" which perceives the abnormal is not the "I" which was wont to perceive the normal. In artificially induced states of unconsciousness (*e.g.* by chloroform) I have seen an insane patient who, whilst under the anæsthetic, gave vent by speech to the same delusion and the same train of ideas as when in his ordinary state of insanity. This fact alone was significant that the *ego* bore a corresponding relationship to the actual cerebral activities in both states.

In the fully awake person the judgment perceives the nature of the events which are manifested to the mind; in sleep, and in insanity, on the other hand, the judgment is weak and there is inability (the "negative lesion" of Hughlings Jackson) to perceive the absurdity and impossibility of the events which appear to happen. One point in which the dream state differs from the insane state is to be found in the fact that in the former a large part of the memory is blotted out, and the mind is unable to compare present facts with the experiences of the past; whilst in the insane the memory for remote events is often unimpaired.

In the insane the dreams are often morbid exaggerations of the waking thoughts, and I have observed many instances in which insane persons have dreamt that they had the usual forms of sensory persecution during sleep as during the wide-awake state. Hack Tuke (*Dict. Psych. Med.*, p. 413) records the case of a lady, the subject of melancholia, who was entirely free from her troubles during the night. It is common, however, for the melancholiacs to have dreams of a dismal and depressing character.

Savage believes that the prognosis as to recovery is good in those insane melancholiacs who have pleasant dreams. In mania the phantasmagoria is very varied, and on awaking the insane person confuses his dream states with actual experiences. In alcoholics especially is this noticeable, and gives rise to the condition known as *paramnesia*. Such patients will frequently assert they have undergone actual experiences, whereas they have been in reality dreamed. In puerperal insanity we sometimes find that the attack has commenced with a particularly vivid dream occurring in the early morning, and it is not uncommon to meet with other forms of insanity which have been an actual continuation or outcome of the hypnagogic state. In a similar manner an insane hallucinatory

condition may be determined by the administration of an anæsthetic, such as ether or chloroform.

According to Lyman, most dreams are composed of visual images. The dreamer looks upon a picture which changes silently before his eyes, without appealing to any other sense than that of sight. He also believes that in certain cases any other sense may become excited, producing illusions or hallucinations as perfect as the images of healthy vision. They may be suggested by external impressions, or they may, at least apparently, find their starting-point in accidental states of the bodily organisation.

It is very questionable whether hallucinations of smell, taste, or common sensation ever do occur in dreams. With regard to smell and taste it is unlikely, as we are unable to conjure up actual tastes or smells apart from their sensible cutaneous or other effects and accompaniments. Most of these phenomena are *illusory*, and are due to the presence of an actual stimulus acting on the organs of sense. All the phenomena connected with the cutaneous sense, the muscular sense, and sensations of pain are productive of illusions, and may be traced to alternations of the specific energy of their nervous connections. Muscular unrest, anæsthesia, paræsthesia, hyperæsthesia, etc., all may be indirectly productive of the various dream illusions. With regard to vision and hearing, however, the habitual reference to these senses renders them particularly liable to act during sleep, and it is with the activities of these two senses that most of the dream states have to do.

Maury states that the ease with which dreams are recollected varies inversely with the depths of sleep in which they occur. The intensity or vividness of the illusions or hallucinations also in part determine their capability of recall. The most important factor, however, is the awakening immediately after the dream and recalling to consciousness the events of the dream. When sleep is continued after a dream there is apt to be failure of registration, and when full consciousness is reached, the dream cannot be recalled. Manacéine believes that the hypnagogic state is most noticeable in stout, phlegmatic, and plethoric individuals, and very rarely in nervous and sanguine persons. When the hypnagogic period is abnormally long, it often forms an early symptom of mental breakdown. For many of the facts connected with the hypnagogic state, it has been argued that there is a complete analogy between the hypnagogic and the hypnotic states. The response or reaction to suggestions from without is somewhat similar. In a series of experiments undertaken by Manacéine, it was found that the hypnagogic state occurred more frequently in children than in adults, and in males more frequently than in females. Too warm a bedroom had a bad influence in producing it.

A psychological analysis of our dreams recorded in the almost classical writings of Maury reveals the fact that dreams are mainly made up of visual images. Visual dreams complicated by auditory representations constitute about 60 per cent of the whole. Purely auditory hallucinations are regarded as occurring only in musicians. As we have already seen, dreams connected with sensations of touch, temperature, and muscular movement, also of taste and smell, occur only as illusory phenomena, and may be traced to some form of actual stimulation present. In general paralysis of the insane, in the ataxic type, where there is loss of muscular sense, the dreams sometimes take the forms of feelings as if the body were flying in the air.

Dreams have been divided into two groups :—

(*a*) Presentation dreams (*nervenreiz Träume*) occasioned or accompanied by peripheral excitation. These would correspond to the illusory types occasioned exoneurally, and any of the senses may be affected.

(*b*) Representation dreams (*psychische Träume*) occasioned by central cerebral excitation, and of the hallucinatory types. The rarity of olfactory, gustatory, and organic hallucinations depends upon the absence of representation in connection with those senses.

Ribot investigated the revivability of smells, etc., in dreams in sixty persons of varying class, age, and sex, and found that in 60 per cent of his subjects there was a distinct and in many cases a very pronounced ability to revive, voluntarily and involuntarily, familiar smells, such as those of many flowers, carbolic acid, etc.[1]

Titchener also believes that taste dreams involve a representative element. When we consider the impossibility of voluntarily reviving either smells or tastes apart from any present objective stimulus, and without any confusion of the actual smell or taste with other sensible effects upon the other senses (*i.e.* smell and taste apart from their usual accompaniments of sight, touch, and common sensation, etc.), we doubt the accuracy of these observations, and it is probably more correct to assume that where there is any representative elements in dreams of tastes or smells, that element is either due to some present objective stimulus, or confusion of the sensible *effects* of a former stimulus—the effects themselves being reproduced, and not the actual smell or taste.

As a general rule, dreams are more numerous in cultured persons, and tend to reproduction of the individual's personal experience in varied forms; in uncultured individuals, on the other hand, dreams are neither so numerous nor

[1] Ribot, *Psychologie des Sentiments*, Contemp. Sc. Series, 1897, pp. 140 *et seq.*

varied. The images in dreams may be so vivid that they persist long after waking, and not a few delusions of the insane have had their origin in dreams. To account for the vagaries is not difficult when we remember that conscious thought and logic are absent during sleep. Mercier (*Psychology, Normal and Morbid*) has recently stated his belief that delusions come into being in precisely the same way as obsessions by the independent and quasi-parastic formation of nervous connections which may take place during sleep, and which are not necessarily attended by any mode of consciousness; and therefore, if we seek the origin of a delusion among processes of thought, we are looking in the wrong direction. He regards the formation of a delusion as not strictly a psychological event — rather in the process

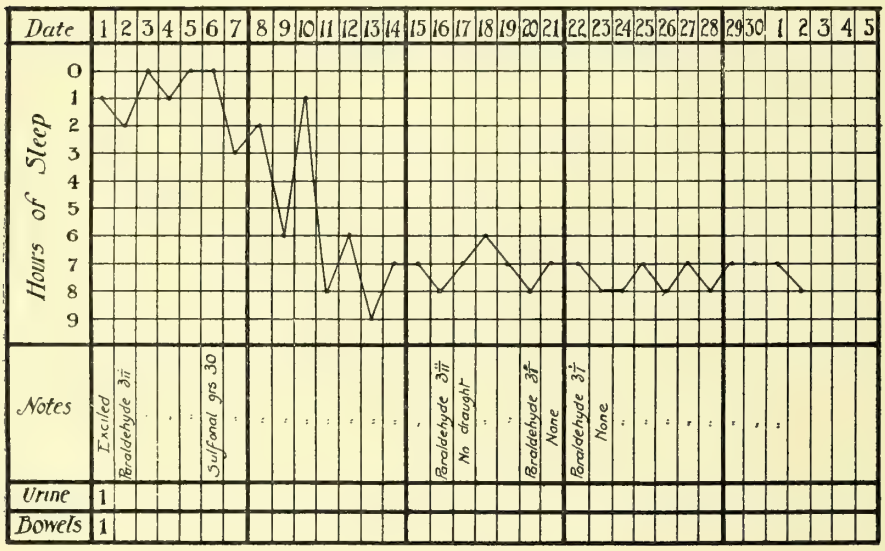


CHART 5.—Disease: Acute Mania (recovered).

closely allied to that to which the name of "unconscious cerebration" has been given.

Morbid dreams may occur with such intensity and vividness as to render the individual practically insane. They also sometimes herald the onset of some brain affection. In hysteria and epilepsy, illusions, hallucinations, and nightmare occur very frequently. Sante de Sanctis found that the dreams of epileptics are more liable to be affected by the weather than those of hysterics, so that in this respect epilepsy merits its ancient name of *morbus astralis* or *lunaticus* (quoted from Manacéine, *Sleep*, p. 295).

Dreams in hysteria are also said to be briefer and less complex than in epilepsy. Epileptic mania may arise during sleep; or there may be a sudden attack of acute mania in sleep quite independently of epilepsy.

SOMNAMBULISM.—This is an affection most commonly manifested in childhood and youth. The eyes are frequently open, and as the vision is more acute and the pupils dilated in the somnambulistic state, the individual can perceive objects with very little light.

The tactile sense is also more acute, even though there may be analgesia. Sometimes somnambules hear and respond to verbal sounds. The senses of smell and taste may remain active. The muscular system is intact, and often very remarkably so. Many instances have been recorded of individuals who in a state of somnambulism have performed intellectual feats in music, literature, and mathematics. Cases are on record also of acts of homicide and suicide during somnambulism. Usually there is little power of recalling the events that have occurred during somnambulism. After recovery from attacks of insanity events may be partly recalled, and this constitutes a slight difference between the two states. The statement that somnambulists never remember what has occurred during their walks is not quite correct. There is in somnambulism little or no conscious adjustment of the individual's acts to the environment. If anything is remembered, it is the dream and not the motor act.

SLEEP IN INSANITY.—As we have already stated, the insane show the most marked abnormalities of sleep. In acute cases there is usually insomnia in the early stages, and it is just as important to keep a chart of the condition of sleep in the earlier stages of insanity as it is to record the temperature in conditions of bodily disease. Insomnia is by far the most frequent of the disorders of sleep. Chart 5 represents in hours the amount of sleep nightly in a case of acute mania with excitement, restlessness, and general confusion of the mental faculties. Normal sleep with the aid of draughts was reached about the third week of the disease.

Chart 6 represents sleep in a case of puerperal melancholia with hallucinations, restlessness, and refusal of food. In this case also normal sleep was obtained about the third week of the attack, and followed by recovery.

Chart 7 shows the intractable nature of the insomnia in the maniacal stages of general par-

alysis of the insane. In spite of large doses of hypnotics and prolonged baths, the insomnia did not yield.

Chart 8 is of a case of senile mechancholia with agitation and refusal of food, which terminated fatally.

Chart 9 is a case of chronic mania with de-

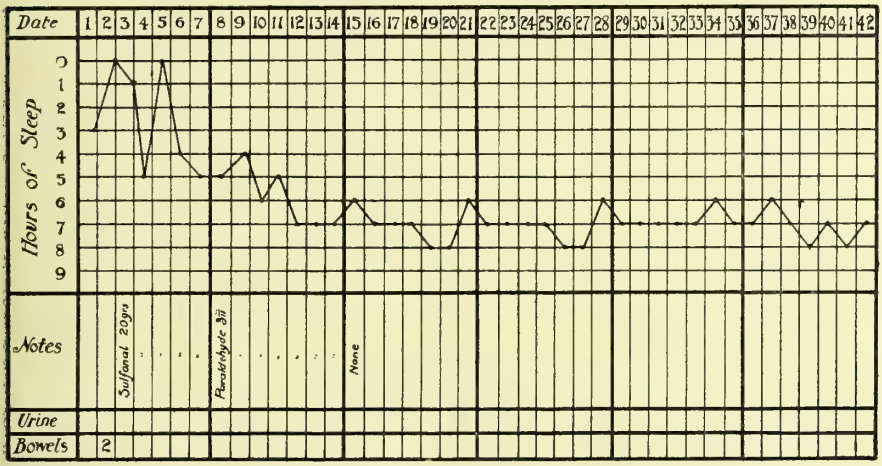


CHART 6.—Disease: Puerperal Melancholia.

lusions of persecution. The chart represents only six weeks' out of several years' continuous insomnia. In this case sleep was very light, and the individual was roused on the slightest stimulation of her senses. Another patient of the same type sat upright in bed for several years and was never found asleep. In the earlier stages of both cases, treatment only succeeded in causing confusion of their ideas without any alteration in the lines of the charts.

Chart 10 is of a typical delusional case without any excitement or depression. The use of a prolonged bath during the daytime served to induce more sleep, but without change in the mental condition.

This case proved incurable.

It will be seen from these charts that long-continued insomnia is unfavourable as to curability. An analysis of the thousands of charts of recorded cases of insomnia in Bethlem reveals the fact that insomnia of a severe type, and protracted beyond a month, seldom results in complete recovery. The brain appears to become too much damaged to be able to recover itself. Often, therefore, a glance at a sleep chart is enough to reveal the nature of the case as regards curability.

TREATMENT.—The treatment of insomnia may be divided into *rational* and *therapeutic*. The rational is chiefly concerned with the acquirement of habits most conducive to sleep. The bedroom ought to be cool, and with a liberal supply of fresh air. Careful attention to minor details are necessary, viz. the height of the pillow, the state of the mattress and bedclothes, the number of coverings; some persons sleep better between blankets than sheets; some individuals are able to sleep comfortably if the two sides of the mattress are slightly raised so as to enclose them in a hollow; sometimes sleep is obtained by constricting the middle of the pillow and adapting it to the neck so as to give complete rest for the muscles of the head and neck. If sleep is liable to be broken by dreams, attention should be paid to all the possible factors of causation. Posture can be rectified by various means. The occurrence of dreams with sexual excitement may sometimes be rectified by tying some object to the back, which when rolled upon awakens the sleeper.

Baths are often extremely useful in obstinate

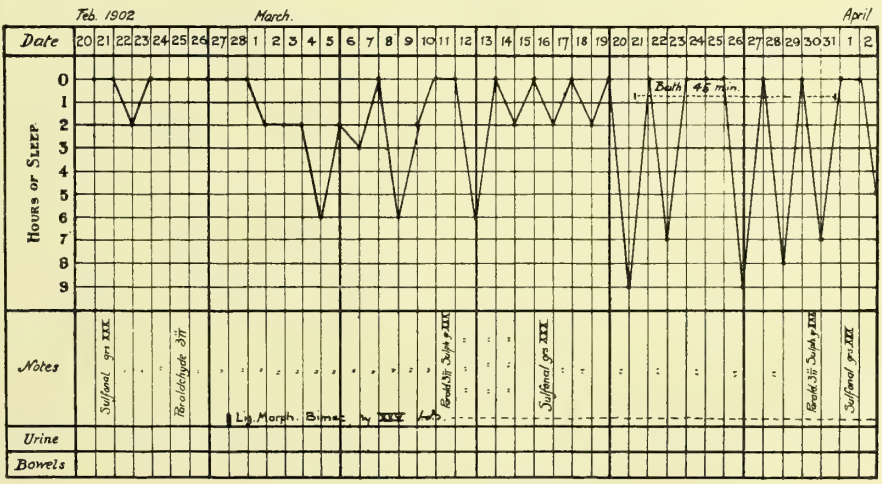


CHART 7.—Disease: General Paralysis.

cases of insomnia, and I have seen good results from the use of prolonged baths for periods of as long as eight hours' duration. Sometimes the addition of a little mustard to the bath may be beneficial. Local applications of cold compresses to the forehead or the use of electricity to the head may be of great use in inducing sleep. I have frequently observed good effects from the use of massage to the muscles of the occiput, neck, and spine, applied for twenty minutes when the patient is in bed and ready for sleep. Diet is important, and in the chronic insane a liberal diet does much to ensure sleep and rest. Posture is sometimes at fault, and not infrequently there is even during sleep some muscular tension due to a somewhat strained attitude. Flaccidity and immobility ought to be sought for, and efforts made to counteract restlessness which stimulates the muscular and cutaneous senses and tends to rouse consciousness.

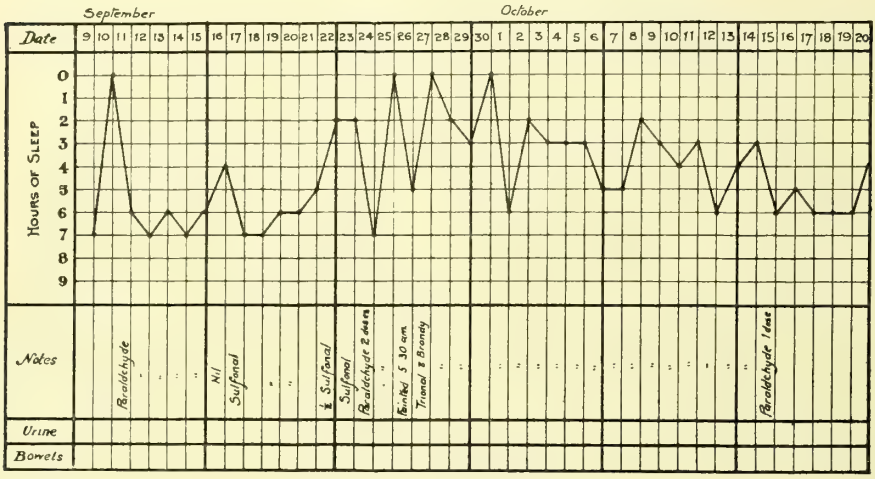


CHART 8.—Disease: Senile Melancholia.

With regard to hypnosis there is much difference of opinion, and it is doubtful how far artificially induced hypnosis is really conducive to refreshing sleep and restoration of exhausted tissues. In agitated states where there is great motor excitement, and especially in agitated melancholia, the use of the dry or wet pack is attended by good results. Psychologically considered, the grosser emotions are often mainly consequent upon or secondary to the violent expression of the emotion, *i.e.* the emotion itself is derived from the reaction to an imaginary or real exciting cause. It is rational, therefore, to check or control the violence of this reaction by artificial means, and it is a well-known fact in the treatment of mental diseases that by controlling the motor excitement its consequent or corresponding emotion ceases. Thus it is that the employment of a wet or dry pack in agitated melancholia has a beneficial effect. When the rational treatment of insane states is more fully and better considered, it will probably be recognised that just as rest, natural or artificial, is necessary in the treatment of bodily pain, so rest, natural or artificial, is necessary in the treatment of mental pain.

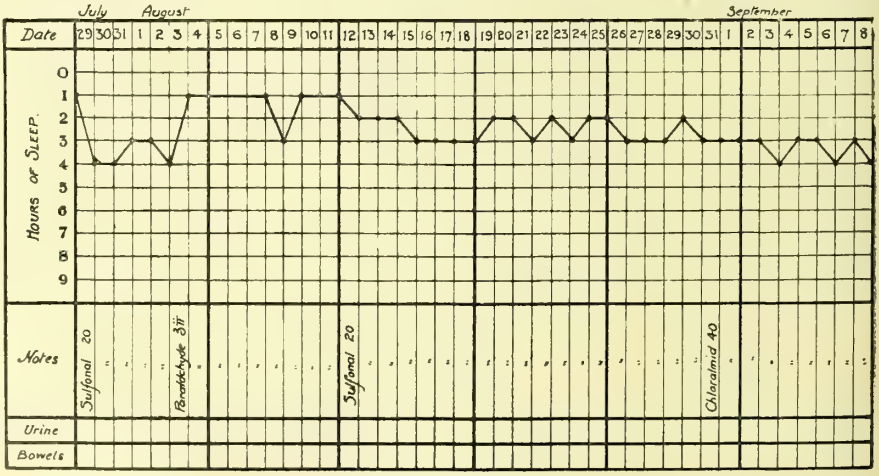


CHART 9.—Chronic Mania.

The use of *hypnotics*, to try to imitate the natural condition of sleep by effecting a lowered intracranial pressure, or *narcotics*, to cause unconsciousness irrespective of diminished pressure, is a source of constant perplexity to the physician. Of the various drugs used, space permits me to mention only briefly the bromides of potassium, sodium, ammonium, lithium, calcium, strontium, rubidium, cæsium, also ferric

bromide, ethylene or ethene bromide, monobromide of camphor, and hydrobromic acid. Bromides, if long continued, are apt to cause weakening of the mental faculties, acneform eruptions, and sometimes œdemaglottidis.

The chloroform and alcohol groups include alcohol, ether, aldehyde, paraldehyde, chloroform, chloral hydrate, chloralamide, urethane, chloral urethane, acetal, methylal, sulphonal, tetronal, amylene hydrate, hyphone. All these drugs have been used with varying success in the treatment of insomnia. Paraldehyde is perhaps one of the best, and can be administered for long periods without bad results. The paraldehyde "habit" may be acquired, and large doses (ʒi.) taken without serious effects.

Sometimes, however, insanity may supervene as a result, and the form is sometimes similar to alcoholic pseudo-general paralysis. Sulphonal is also very frequently used, but has to be administered with caution. Its slowness of action, its insolubility, and tendency to accumulate in the intestinal canal render it at times dangerous even to life. Its ill effects are headache, giddiness, staggering gait, confusion of ideas and difficulty of speech, occasionally a scarlatiniform or measly rash, vomiting, and hæmatoporphyrinuria. Erlenmeyer believes that the dose should never exceed 30 grains, but this dose is useless in some cases of urgency. I have occasionally given 60 grains with good results. It is contra-indicated in cases of melancholia with sluggish bowels.

Opium and its alkaloids must be given with caution. It is sometimes good for temporary use, but usually does harm if long continued. The bimeconate of morphia is useful in conditions of agitated melancholia.

Hyoscyamine and hyoscine are useful in the treatment of insomnia in the chronic insane, but should be given with great caution where recovery is to be looked for.

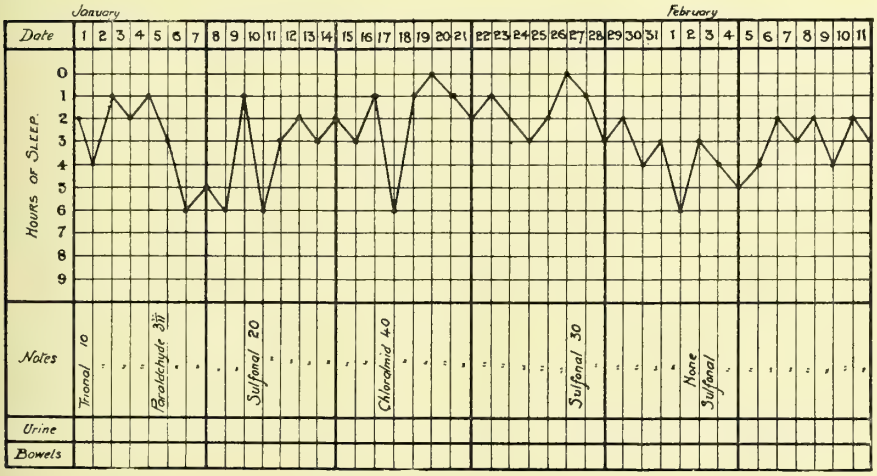


CHART 10.—Delusional.

Sulphate of duboisine, cannabis indica, conium, Calabar bean, boldine, and boldo-glucine have all had trials.

Boldo-glucine is said to possess hypnotic powers without causing anæsthesia, but its properties have not yet been sufficiently investigated.

Sleeping Sickness, or Negro Lethargy.

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Definition.—A chronic meningo-encephalomyelitis, characterised clinically by progressive physical and mental lethargy, terminating in death.

Geographical Distribution.—Sleeping sickness is endemic in tropical West Africa. It occurs in more or less circumscribed districts, from the Senegal to San Paulo do Loanda. It is very common along the middle reaches of the Congo. Although principally a disease of inland districts, it occurs on the coast and islands, as for example in Fernando Po and the Ilha do Principe. It has been met with as far inland as Timbuctoo on the upper Niger, at or near Stanley Falls on the Congo, and on the shores of Lake Tanganyika. Until recently this disease, apparently, was confined to the western watershed of the African continent, but within the last year or two it has invaded Uganda, and is at present extensively epidemic in that country and in other and neighbouring districts in the upper part of the Nile basin. So far there is no reliable account of its endemic occurrence in any other part of the world, although there is some reason to think that it may occur among the aboriginal tribes of Guiana, South America.

Although sleeping sickness can be acquired only in the endemic area described, owing to the great length of the incubation period in some instances—seven years, it is said—the clinical manifestation of the disease may take place in any part of the world. Hence in the days of the slave trade the disease was common enough in the West Indies, but only among the im-

ported negroes. Some years ago a negro lad succumbed to sleeping sickness in England after three years of good health in this country.

Race.—So far there is no well-authenticated case of sleeping sickness in a European. Mulattos and Moors are susceptible, and there is no adequate reason to suppose that the European, provided he is exposed to the infection, whatever this may be, would prove insusceptible.

Epidemic Characters.—Within the endemic area the disease clings to particular villages. It is not generally diffused throughout the endemic districts. It affects particular foci, but may be introduced into villages hitherto immune. When so introduced it may spread and cling to the place for years, leading in the course of time to a heavy aggregate mortality. In this way villages, and even whole districts, have become depopulated. When it appears in a house, parents and children, young and old, males and females, are equally liable to attack. In the villages in the endemic regions on the Congo it is usually possible to find several cases in progress, so common does it become.

Symptoms.—There is considerable variety in the character and grouping of the symptoms of sleeping sickness, as well as in the rate of progress of the disease. As regards the latter, about one year seems to be an average duration, but a rapid case may prove fatal in three months, and a more chronic case may last for several years—up to three at least.

An average case proceeds much as follows. With or without occasional attacks of feverishness, headache, or rachialgia, the patient, previously quite healthy, becomes conscious of impaired muscular power and endurance. He tires easily at his work. His mind is similarly affected; he comprehends slowly and with difficulty, conversation becoming an increasing burden to him. At the same time, apparently in consequence of the physical and mental languor, he is prone to fall asleep at unusual times, even while at work, during his meals, or during a conversation. Gradually this lethargic condition becomes aggravated. There may be temporary improvements, but on the whole the condition becomes more pronounced. The patient, from weakness or indifference, is apt to stagger in his walk; or he may shuffle slowly along, neglecting, or being unable, to lift his feet off the ground. When standing or sitting, his body tends to lean to one side, as if the effort to maintain the erect posture were too much for him. His upper eyelids droop, and the tonicity of the facial muscles relax, the expression of the face becoming vacant or mournful. He is dull or morose. Spontaneity ceases. He will eat when food is brought him, but he does not ask for it. He takes no part in conversation, and confines his answers to monosyllables. His answers, though delayed, are to the point. At this stage the patient passes most of his time asleep, or apparently asleep, indifferent to everything about him. He can be roused easily enough, but drops off asleep very quickly. While eating he may fall asleep.

Up to this stage, if the patient be carefully tended, nutrition and the organic functions are adequately fulfilled; but sooner or later he begins to lose weight, bed-sores may form, muscular spasms or epileptiform seizures may set in, or some grave intercurrent disease may be established, such as dysentery, diarrhœa, pneumonia, sepsis, phthisis, and so forth, and the patient dies.

In the majority of cases muscular tremor and fibrillar twitchings are marked features, either throughout the disease or towards its termination. Sensation is not manifestly affected. Spasm of certain groups of muscles, often followed by paresis, is not uncommon. Retraction of the head is not unusual, especially towards the end of the disease.

Two additional symptoms may be noted in nearly every case of sleeping sickness, namely, pruritus and enlargement of the lymphatic glands, especially those of the neck. The pruritus, which may be accompanied by a papular or papulo-pustular eruption, is generally most intense over the chest and abdomen. The skin loses its natural gloss, and is scored all over with long white lines of abraded epithelium produced by the incessant scratching. The enlargement of the lymphatic glands may be marked or slight. The individual glands are discrete, not matted, and not adherent to the skin. They may be tender, but do not suppurate. In size they vary from that of a small bean to a walnut.

The senses are not manifestly involved. The fundus oculi, the superficial and deep reflexes, are normal. No abnormality has been remarked as regards the secretions except, perhaps, that the saliva may be increased in amount; at all events, whether it be from increase of the amount or from inattention to swallowing it, in many instances large quantities of saliva dribble from the patient's mouth as he lies asleep.

It not infrequently happens that the disease is ushered in by a violent maniacal attack, or such may be interpolated during its progress. Similarly, there may be initial or intercurrent epileptiform seizures.

Morbid Anatomy.—Recent and carefully made examinations have shown that there is no gross lesion essential to sleeping sickness; so far as naked-eye appearances are concerned, the encephalon may seem to be healthy. It is not unusual to see some thickening and opacity of the pia-arachnoid over the convexity of the cerebrum, and perhaps slight turbidity of the cerebro-spinal fluid. In other cases similar evidences of meningeal inflammation are more pronounced. The essential lesion, however, is

detectable only by the microscope, and consists in, as was first pointed out by Mott, an extensive lepto-meningitis and encephalo-myelitis. Throughout the whole of the central nervous systems microscopical sections show the pia-arachnoid infiltrated with numerous small mononuclear leucocytes. This infiltration can be traced along the blood-vessels and septa into the substance of the nervous system. The perivascular lymphatics around the large and small vessels are crowded with lymphocytes, similar cells being scattered about and between the nerve cells and fibres. There are secondary changes in the nerve elements, but they are of a character not nearly so pronounced as in general paralysis of the insane, a disease to which sleeping sickness appears to have many clinical affinities.

Mott found inflammatory infiltration of the lymphatic glands, and also, in sections of the duodenum, large numbers of lymphocytes, as well as increase in the size of the lymphatic nodules. So far as they go, Bettencourt's observations confirm those of Mott on the histology of the nervous system.

Etiology.—Bettencourt claims to have discovered in the cerebro-spinal fluid and elsewhere a micrococcus which he regards as the cause of sleeping sickness. Observations in England do not support this. Cultures of blood and lymphatic tissue in competent hands gave negative results as regards the presence of bacteria.

The morbid anatomy of the disease favours the supposition that the virus acts primarily through the lymphatic system, but what may be the nature and source of the virus has not been ascertained.

A curious circumstance, which may or may not have a bearing on the etiology, lies in the fact that in the vast majority of the cases in which the point has been critically investigated the subjects of sleeping sickness are also the subjects of infection with *Filaria perstans.* Thus in 3 cases carefully examined in England this parasite was found in all of them. It was present also in a large number of films of blood derived from cases of sleeping sickness on the Congo, and in 33 cases recently investigated by Dr. Howard Cook in Uganda, the parasite was ascertained to be present in 30. As we know that *Filaria perstans* after being present may disappear from the blood, it is not unreasonable to think that it may have been present at one time or another in every case of sleeping sickness. An intimate association between parasite and disease is further suggested by a study of their respective endemic areas, which, so far as Africa is concerned, and so far as we know, are identical. On the other hand, many negroes — 50 per cent — in some districts harbour *Filaria perstans,* but only a relatively small proportion of them get sleeping sickness. If it be that this parasite is the cause of the disease, some additional and as yet unrecognised factor must co-operate.

It has been suggested that sleeping sickness is communicated by the saliva. The negroes in some places entertain this idea. The negroes eat together, using their fingers to convey their food from a common dish to the mouth, and so, it is said, convey the virus.

Treatment.—So far, no treatment has proved of material value. Something may be done to prolong life by assiduous attention in feeding and nursing.

[The cause of sleeping sickness is now known to be a species of trypanosome—*T. gambrense.* Dullon was the first to identify a case of human trypanosomiasis, and in 1902 Castellani found trypanosomes in the cerebrospinal fluid of a case of sleeping sickness. This observation has been abundantly confirmed, especially by the work of Bruce, Navarro, and Greig in Uganda, who showed that the trypanosome could be detected in every case of the disease. Man is infected through the agency of a species of tsetse fly—*Glossina palpalis;* possibly other species of *Glossina* may also convey the infection. The game in an affected area probably acts as a permanent reservoir for trypanosomes; Koch recently has ascribed especial importance to the crocodile in this respect. No certain means of curing sleeping sickness is known. Atoxyl, an arsenic compound, and trypan roth, an aniline dye, have been shown to control or check experimental trypanosomiasis in animals, and have apparently proved beneficial to man. In so protracted a malady as sleeping sickness, however, a longer time must be allowed to elapse before it can be said that either of these drugs is curative.]

Sleeplessness.—Insomnia. *See* Sleep, Normal and Morbid (*Sleeplessness*); Alcoholism (*Treatment, Sleeplessness*); Heart, Myocardium and Endocardium (*Treatment of Sleeplessness*); Insanity, Pathology of (*Pathogenesis, Insomnia*); Mental Deficiency (*Primarily Neurotic Type*); Morphinomania and Allied Drug Habits (*Cocaine, Effects*).

Slough. *See* Gangrene; Sphacelus.

Slow Heart. *See* Heart, Neuroses of (*Bradycardia*).

Sludge.—The solid residue left after the chemical treatment of sewage; it is usually obtained by subsidence and precipitation, and also by the action of such chemical substances as lime, or sulphate of alumina, or blood, or black ash waste; and the sludge or final product should not be injurious to health. *See* A.B.C. Process; Conder's Process; etc.

Smallpox.

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See also Bronchi, Bronchitis (*Etiology*); Conjunctiva, Diseases of (*Exanthematous Conjunctivitis*); Disinfection (*Incubation Periods*); Epidemiology (*Seasonal Fluctuations*); Heart, Myocardium and Endocardium (*Simple Endocarditis, Etiology*); Joints, Diseases of (*Pyogenic Diseases*); Kidney, Surgical Affections of (*Perinephritis, Etiology*); Leucocytosis (*Causes*); Measles (*Diagnosis*); Mental Deficiency (*Varieties, Post-Febrile*); Nails, Affections of the (*Diseases of the Skin, Acute Exanthemata*); Nephritis (*Etiology*); Nerves, Peripheral (*Neuritis, Causes*); Nose, Accessory Sinuses, Inflammation of (*Etiology*); Pleura, Diseases of (*Acute Pleurisy, Causes*); Pregnancy (*Intra-uterine Diseases*); Purpura (*Symptomatic, Infectious*); Skin Diseases of the Tropics (*Infective Diseases*); Vaccination.

Definition.—Smallpox is a highly contagious specific fever, attended on the third day of illness by a characteristic inflammation of the skin, becoming first papular and ultimately pustular; resulting frequently in death, but often in recovery, the lesions of the skin commonly leaving permanent scarring or disfigurement. One attack, as a rule, protects from recurrence.

History.—Smallpox is known to have been indigenous in Eastern countries for nearly two thousand years, its earliest records coming from India and China. The first appearance in Europe seems to have been in the sixth century, when fatal epidemics broke out in Southern France and Northern Italy. England appears to have been first severely visited about 1241, and at this time the disease was widely spread throughout Europe. From Europe smallpox was conveyed to the American continent, first to Mexico in the year 1527, where it raged to a fearful extent, destroying millions of victims, and spreading thence to other parts of America, which it gradually overran.

Smallpox has been one of the greatest, if not actually the greatest, of the scourges of mankind: no form of disease has been more destructive of life, none has brought more misery in its train. In Europe not a decade passed in which the disease did not overrun great tracts of country, decimating the inhabitants in its progress. In England in the seventeenth and eighteenth centuries a large proportion of the medical literature bears upon the treatment of smallpox, showing that that disease was the common form of illness which the physicians of those days were called upon to treat. The records of the mortality from smallpox in the eighteenth century show that it accounted for nearly one-tenth of the total mortality, that neither age nor sex nor social conditions afforded protection, and that of those who recovered from it, the number permanently scarred or disfigured formed so large a proportion of the population that unmarked persons were comparatively few.

Escape from smallpox was regarded as so improbable, that in the East, from a remote period, the practice had been in vogue of intentionally inoculating persons from a mild case of smallpox, in the hope that the inoculated person would also contract the disease in a mild form; and this hoped-for result appears to have been frequently realised, but yet it was attended with the grave difficulty, that any one so inoculated was liable to impart the disease to a susceptible person in an unmodified form, and each inoculated person was a new focus of infection. Inoculation was introduced into England in 1721, and, notwithstanding the dangers and grave objections attaching to it, was continued until the introduction of vaccination, which put an end not only to it, but exercised an influence upon smallpox which constitutes the most remarkable of all triumphs over disease ever achieved by medical science.

Causation.—Smallpox differs from most other infectious diseases in being apparently uninfluenced by conditions of soil and climate; it breaks out wherever predisposed individuals are exposed to it, independently of geographical conditions. The poison of smallpox is eminently contagious, perhaps more so than that of any other form of infectious disease. Natural susceptibility to it is almost universal, but children are even more liable to it than adults.

Negro races are said to suffer more severely than others. There is no ground for supposing that existing diseases of any kind, acute or chronic, lessen the susceptibility to smallpox.

The writings of physicians, more especially of the seventeenth and eighteenth centuries, show that individual insusceptibility did occur, though rarely, and it is equally plain from these writers that mild forms of the disease were by no means uncommon. One attack of smallpox usually confers an immunity for the rest of life, but instances occur, relatively rare no doubt, in which a second attack takes place, or indeed even a third may be possible; in most authenticated examples of second attacks the first one has usually been mild in character, and many years have elapsed between the two attacks. The case of Louis XV. of France is the best-known instance of a second infection; that monarch first suffered from smallpox at the age of fourteen, and again at the age of sixty-four, the second attack causing his death.

Although the exact nature of the smallpox contagion is not definitely known, the results of inoculation conclusively prove that the poison is contained in the skin eruption. The manner in which smallpox spreads by contagion

makes it plain that the virus multiplying in the body of a smallpox patient is conveyed directly or indirectly to a predisposed individual and infects that person. The contagion is exhaled from the skin and lungs of the patient, is probably contained in secretions and excretions, and beyond doubt it adheres to clothing, and articles, and places with which the patient may have come into contact. Hence, the attendants may convey infection, or it may be received by entering a house from which the patient has been removed. The patient may communicate the disease from the initial stages of his illness up to the completion of convalescence, and the bodies of the dead also convey infection. But experience points to the suppurative stage as the most dangerously liable to spread infection. The contagium of smallpox operates at a far greater distance than that of any of the other forms of infectious disease, and this volatility of the poison is one of the most important and difficult matters to be dealt with in the prevention of this disease. The following example which came under the writer's notice in 1886 illustrates this point, and serves also to prove the impossibility of domestic isolation unless every person within the range of infection is protected by vaccination: A girl, nineteen years of age, contracted smallpox at her place of business, and when taken ill went to her home at 94 B. Street, where she died on the twelfth day of illness, the Registrar's certificate being the first intimation to the health authorities. There was no smallpox known in the district prior to this. Although the family at 94 B. Street were new-comers to the district, and had but few acquaintances, yet within the next ten days following upon the girl's death, no less than 38 cases of smallpox were found in the immediate neighbourhood of this house and were removed to hospital, the stage of the illness of each of these cases proving that they had been infected during the time the girl lay ill at No. 94; their locality served to identify still further the source of infection. Facts such as these also indicate the necessity for care in the selection of the site for smallpox hospitals (*see* p. 236).



FIG. 1.—Mona W., aged 7. An unvaccinated child. Illustrates variola discreta, at the twelfth day of the disease.

SYMPTOMS AND COURSE OF THE DISEASE.—*Incubation.*—Between the moment that a person is infected with smallpox and the consequent outbreak of the disease there is a period of incubation during which there are no definite symptoms of illness, although occasionally there may be languor and malaise. This period is singularly constant in every case of smallpox, whether modified or not. In every instance in which it can be fixed with precision the period is almost invariably found to be twelve days, or, to be more precise, twelve times twenty-four hours. The intensity of the infection of smallpox is such that one single brief exposure usually results in infection, and hence it happens that the duration of incubation in this disease is accurately known. A margin of variation of a few hours in the onset of the initial rigors may be accounted for by the hour of exposure not being definitely ascertained.

Invasion.—At the termination of twelve days from the time of infection the *invasion* of the disease commences with sudden onset. It is characterised by rigors, sickness, intense headache, and severe pains in the back and limbs, accompanied by rapid rise of temperature, which reaches 103°, 104°, or even 105° within twenty-four hours. The aspect of the patient at this stage is indicative of serious illness, his condition usually being one of complete prostration. In the case of infants and young children this initial stage is often ushered in with convulsions.

The symptoms of invasion are liable to vary in intensity, and are not all always present in the same degree. In one patient headache is

the pain principally complained of, in another the pain in the back or limbs. The sudden rise in temperature is very constant, and extreme constitutional disturbance is common. In all extensive epidemics rare cases occur in which death takes place during this stage. There is, however, as a rule, no relation whatever between the severity of the initial stage and the subsequent progress of the disease. The prognosis at this stage can best be guided, and indeed can only be guided by the condition of the patient as regards vaccination. The stage of invasion, or initial stage, lasts three days, a few hours' margin being allowable for uncertainty in fixing the precise period of onset, and throughout the whole of this stage the high temperature is maintained.

It is during this period that the *initial* or *prodromal* rashes appear. These rashes, which are by no means infrequent, and which may occur indifferently in cases mild or severe in their after-course, are of two forms, erythematous or petechial, either of which may appear on the second day. The erythematous may be scarlatiniform or faintly measly in character, widely diffused, and usually disappear in less than twenty-four hours. The petechiæ are commonly met with about the abdomen and thighs, and fade in about twenty-four hours. They are of no prognostic value, and are not of serious import, but they must never be confused with the hæmorrhagic spots which appear in hæmorrhagic smallpox upon the trunk and extremities at about the same stage. These latter are much larger than petechiæ, varying in size from a split pea to half an inch or more in diameter, and are very dark in colour; their distribution also is entirely different.

The general symptoms which have been described usually attain their maximum on the

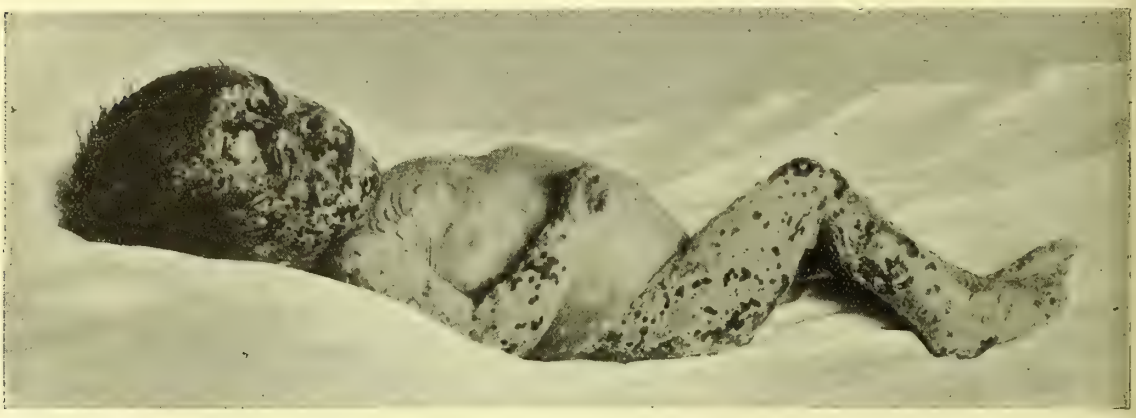


FIG. 2.—An unvaccinated infant, aged 9 months, which died on the tenth day of the disease.



FIG. 3.—Mary M., aged 3 months, also survived until the tenth day of the disease.

third day, and it is on the third day of illness that the first signs of the characteristic eruption appear.

Eruptive Stage.—The earliest indications of the eruption appear almost invariably as small pinkish maculæ upon the face—the forehead, eyelids, nose, and lips becoming more or less thickly studded. Almost at the same time, perhaps a few hours later, similar small red spots appear upon the wrists, and in succession in varying numbers upon the arms, trunk, and legs. These small spots eventually develop into pustules. By the end of the second day after their appearance, *i.e.* the fifth day of the disease, they have increased in size into red elevated papules; on the sixth day of the disease they have become vesicular, and the vesicles continue to enlarge until the seventh or eighth day, when they have reached the size of a pea, and usually present a central depression or umbilication; the vesicle is loculated, and consequently if punctured does not discharge its entire contents. Signs of suppuration may be evident on the eighth day by the increasing turbidity of the contents of the vesicles, which by the ninth day are completely converted into pustules. The adjacent skin becomes inflamed and swollen, more especially the head and face, where the lax connective tissue opposes less obstruction to the swelling. The eyelids are completely closed, and the eruption and tumefaction render the patient wholly unrecognisable. The condition is attended with great pain and discomfort, most complained of where the skin is least yielding, for example the fingers and toes.

The mucous membranes of the nose, mouth, and pharynx are simultaneously attacked by the eruption, also the tongue and larynx and trachea, giving rise to respiratory troubles. The pocks on the tongue and mucous membrane of the mouth are altered in appearance by the fluids with which they are macerated.

The *general condition* of the patient during the development and progress of the eruption is important, and the earlier phases of this stage derive additional interest from their value in differential diagnosis.

As already stated, the first indication of the eruption is upon the third day, at a time when the febrile and general constitutional disturbances are at their maximum. But with the appearance of the eruption a most important change occurs. In all forms of the disease the temperature falls, and the general condition of the patient markedly improves. In the case of smallpox modified by vaccination—and these constitute the majority of cases met with in these days—the fall in the temperature is rapid, the subsequent development of the rash is abortive, and the patient usually proceeds to an uninterrupted convalescence. In unmodified smallpox, however, the decline in temperature is slower, the general relief less marked, and with the progress of the inflammation of the skin the high fever and suffering return, the temperature never perhaps having reached the normal (*see* Charts), sleeplessness and delirium adding to the gravity of the case.



FIG. 4.—Elizabeth M., aged 32; she had three good vaccination scars from vaccination in infancy. The disease is exceedingly mild, eruption sparse. Photograph taken on ninth day of illness.

About the eleventh or twelfth day of the disease, the pustules begin to dry and scab, the process usually following the sequence of their appearance. A yellowish exudation takes place, first upon the face, followed by desiccation, and accompanied by a characteristic offensive odour.

Pain, tenderness, and swelling meantime gradually disappear.

After a variable period, extending perhaps to eight, ten, or twelve weeks or more, the falling-off of the scabs is completed, as also the desquamation of adjacent skin. For a varying period the hyperæmic condition of the sites of the scabs persists, leaving reddish blotches, especially marked in cold weather. These ultimately disappear, but the scarring which results from destruction of the skin persists through life. Loss of hair is common, but the loss is not as a rule permanent, unless the pocks on the scalp have been deep.

Convalescence is frequently interrupted by the occurrence of boils, which often recur to a most troublesome extent for many weeks. Bronchitis is frequent; pleurisy, and inflammations of the joints, are not uncommon.

Conjunctivitis is a not infrequent complication. An ulcer often occurs on the cornea, commencing at its edge.

Clinical Variations in Smallpox.—It will be obvious that there are considerable variations in the type of smallpox, and it is necessary that three prominent types should be specially alluded to.

Variola confluens is a term usually applied to those forms of smallpox in which the eruption covers practically the whole of the body; over large tracks of skin the pocks completely coalesce, more especially this is the case on the face, hands, and arms, whilst on other parts of the body they are closely crowded together. The mucous membranes and the larynx are usually implicated. High temperature and delirium are prominent symptoms. Recovery from this form of disease is the exception; when it does take place convalescence is slow, and great permanent disfigurement ensues.

Purpura Variolosa.—This name is given to the happily rare form of smallpox believed to be associated with the hæmorrhagic diathesis, and which is characterised by extensive hæmorrhages into the skin, and of internal parts.



FIG. 5.—Mary D., aged 23, had never been vaccinated. The illustration shows the twelfth day of illness, and is in marked contrast to the preceding vaccinated case. The eruption is confluent. Constitutional disturbance was great, and convalescence exceedingly protracted, but the patient ultimately recovered, though with permanent scarring and disfigurement.

Variola hæmorrhagica pustulosa, as the name implies, associates the hæmorrhages with the ordinary eruption of smallpox. Hæmorrhages occur in the papules, and also in livid spots on the trunk and limbs, and the condition of the gums resembles that seen in scurvy; bleeding from the nose and rectum, hæmaturia, and in women metrorrhagia, are frequent. The initial symptoms in this variety are severe, the secondary fever usually low and accompanied by great prostration. Both forms of disease are almost always fatal.

Varioloid.—Varioloid is the name commonly given to a form of smallpox, mild in course and short in duration, and which, in fact, is the form

that the disease commonly takes when it attacks those who have been previously vaccinated. The term "modified smallpox" is equally applicable. Vaccination (*q.v.*) protects most persons completely for a certain length of time from smallpox, but the longer the term of years since this protection was afforded, the less will its influence be, consequently the terms "varioloid" or "modified smallpox," under which are included all these modifications, must be regarded as comprehensive ones. Generally speaking, the initial symptoms do not differ from those already described. They may, however, be of shorter duration, and the illness may terminate with the appearance of a pimple or two upon the face or wrists, the temperature falling abruptly to the normal; indeed, but for the association of the illness with other cases of smallpox there would be nothing to be considered pathognomonic in cases such as these. The initial exanthemata, already described, are met with in varioloid; the erythematous rashes are said by authorities only to occur in this variety of the disease, and to be not infrequent.

The true eruption presents every variety in amount, and it may abort completely at the second, third, or subsequent day of its appearance, instead of following the usual course, and convalescence at once commences. The eruption, though discrete and sparse in its distribution, is quite characteristic, and except for this limited distribution, and the abrupt check to its development, it answers the description given; it is chiefly upon the face, wrists, hands, and forearms, and very sparsely scattered on the trunk and limbs, very little on the back. In rare cases the disease runs a more severe course, approaching the unmodified disease.



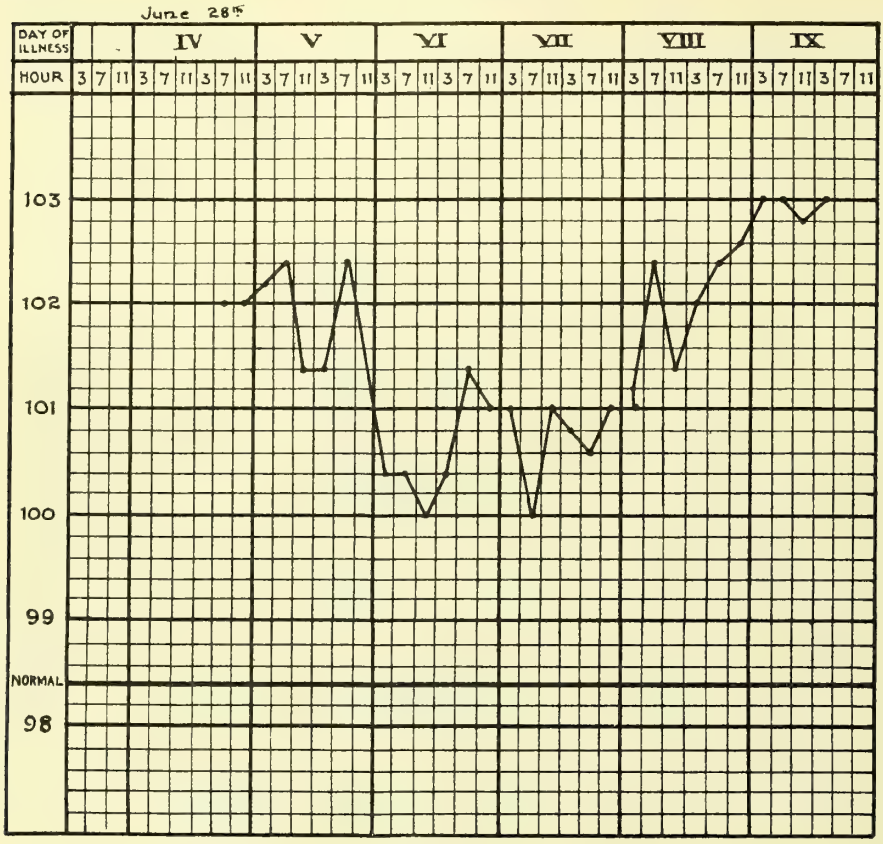
FIG. 6.—James B., aged 44. Had been vaccinated in infancy, one faint scar bearing evidence of the fact, and he had been re-vaccinated on the second or third day of incubation of smallpox, two places developing fairly well. The eruption is seen (sixth day of illness) to be exceedingly sparse, and the constitutional symptoms were trifling.

The following cases are illustrative of some of the salient clinical features, and must be noted in connection with the accompanying charts:—

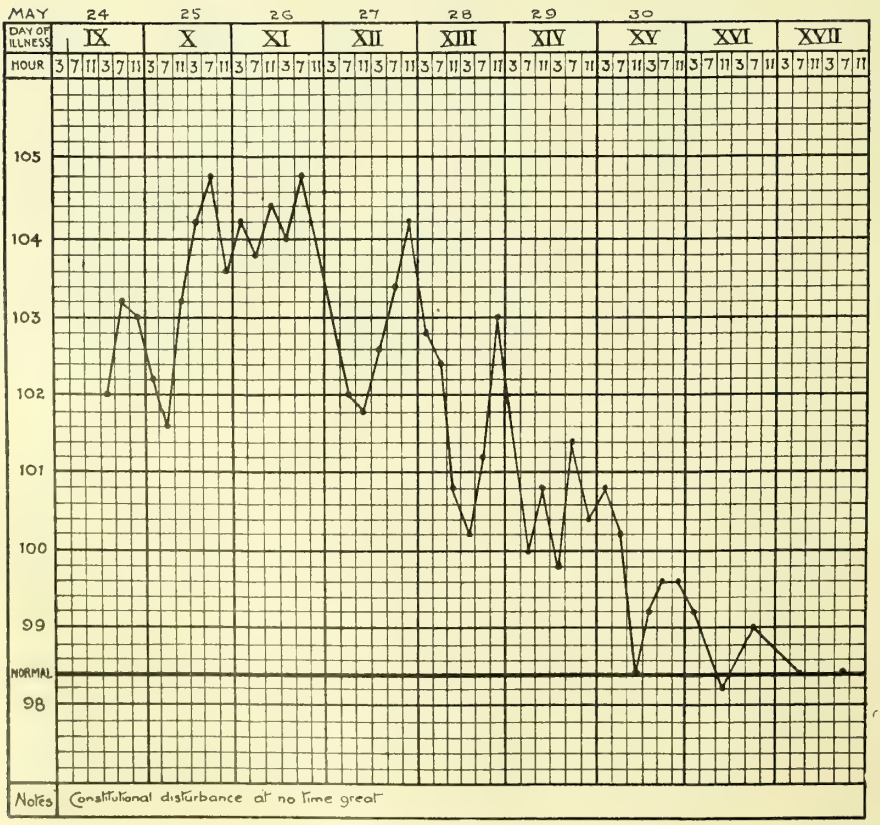
CASE I.—Kate H——, aged 10.—Admitted June 28th, on the fifth day of the illness, with a very diffuse rash cohering over the entire face, arms, and hands, patches of cohering eruption on trunk and legs, but more scanty on the back. Stage of rash vesicular. Frequent cough, laryngeal in character; eyes suffused; patient moaning and delirious; numerous dark, hæmorrhagic spots on the back, chest, and legs; eruption evident about the tongue, sordes, blood-like on lips and teeth; occasional efforts to vomit, patient constantly grinding her teeth.

The eruption progressed in the usual way during the next twenty-four hours, the patient in the meantime remaining more or less delirious. Some sleep had been procured after bromide of potassium, but when awake the patient required careful restraint to prevent her rubbing or scratching the affected parts.

Numerous bullæ containing blood-stained serum apparent about the face. Several of these have been rubbed by the patient, leaving large abrasions on various parts of the face; a similar condition exists on the right wrist. The cough continues, and is relieved by spraying



CASE I.



CASE II.

with glycerine and tannin and chlorate of potash. No further hæmorrhagic spots have developed.

The subsequent progress of the case corresponds with the description already given. The patient died on July 3rd, the eleventh day of illness, practically at the commencement of pustulation. The course of the temperature whilst under observation is shown on the chart.

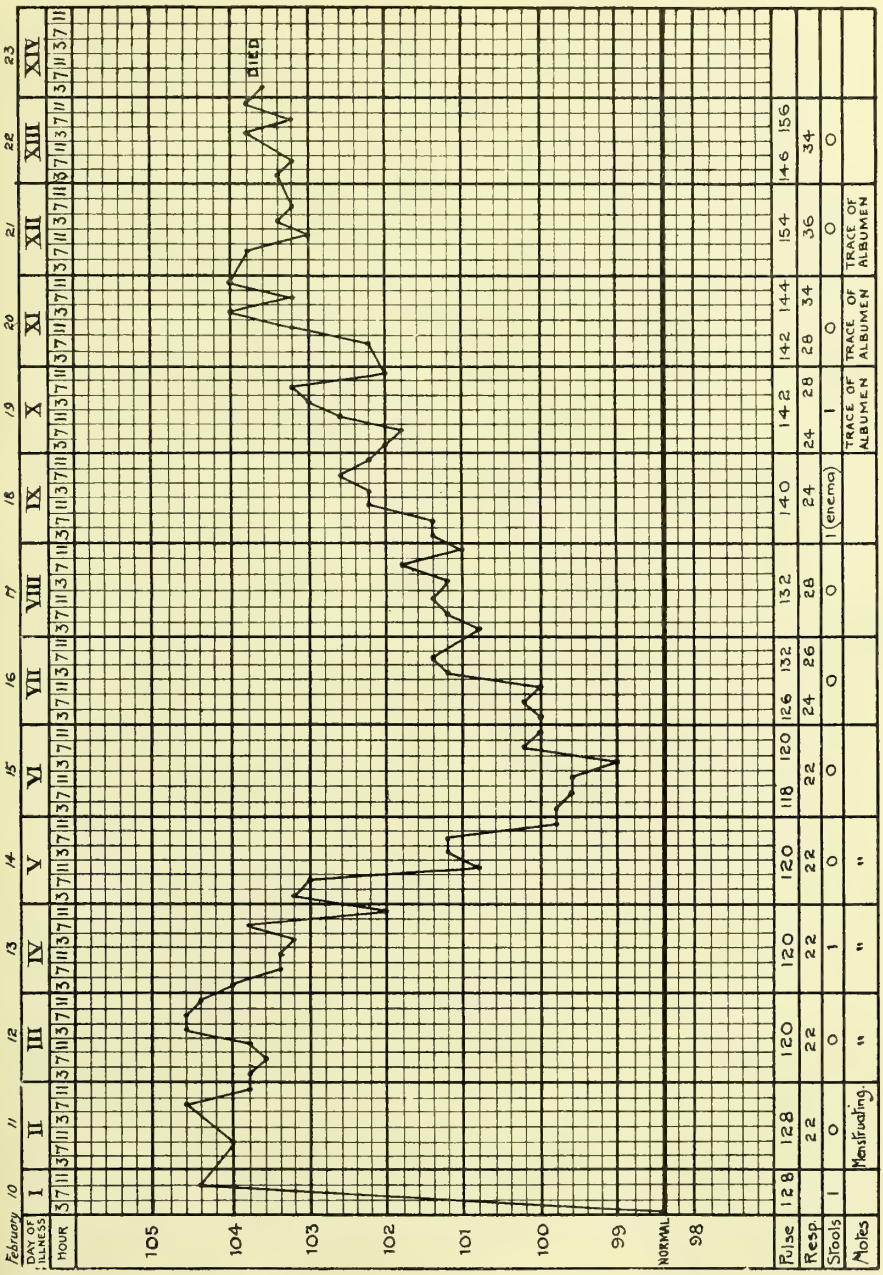
CASE II.—Sarah P——, aged 12; unvaccinated.—The whole course of the disease in this case was mild, secondary fever lasting only about eight days, as indicated by the chart. The temperature having regained the normal, convalescence was uninterrupted.

CASE III.—Jane W——, aged 22; unvaccinated.—The case derives interest from the circumstance that the patient came under observation on the first day of illness, and the course of the temperature is consequently recorded from the commencement to the termination.

The disease took the confluent form, was attended with

hæmorrhagic spots, and in the salient points resembled Case I.

Cases IV. and V.—The course of fever in two more confluent cases is indicated in the cases of Louisa H——, aged 7, and John P——, aged 39, both being unvaccinated.



Case III.

In marked contrast to these may be placed the cases of the disease modified by vaccination. The duration and severity of the illnesses are fairly indicated by the course of the fever.

Case VI.—Henry N——, aged 21; vaccinated. —The illness commenced on the morning of July 16th with violent shivering, followed by intense headache, pains in the back and limbs, nausea, and vomiting. On the morning of the 18th he observed some faint spots on his face, and he was admitted to hospital on July 19th with a few small shotty papules about the size of a pin's head, but with distinct areola on the face, wrists, and arms. On the lower part of the abdomen and the upper part of the thighs were scattered a considerable number of some petechiæ; these were also met with on the sides of the body, extending up to the axillæ.

On July 20th a few of the spots on the face were vesicular, the others drying up, those on the arms and hands were more shotty, and a very few more papules had appeared on the

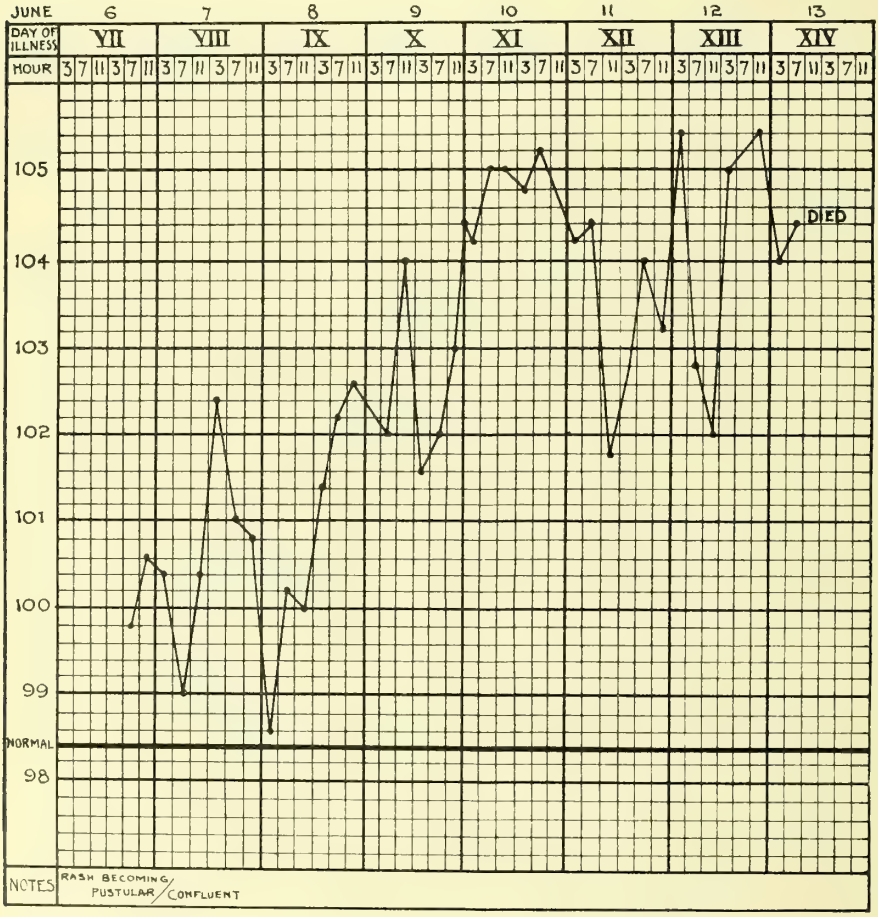
back and legs. The petechial rash had almost entirely disappeared.

July 21*st*.—The vesicles on the face had become pustular, buttery yellow in colour, umbilicated, temperature sub-normal.

July 22*nd*, 23*rd*. — Progress satisfactory, petechiæ still faintly discernible, the eruption drying and scabbing.

Complaints of the throat feeling a little husky, a condition which ceased to be mentioned after twenty-four hours.

The course of the temperature in a few



Case IV.

typical cases is indicated on the charts of Cases VII. to IX. :—

Jane W——, aged 12 ; M. W——, aged 14 ; Matilda B——, aged 15.

In each case the eruption was extremely sparse.

In connection with the differential diagnosis of smallpox, difficulties are only likely to arise in the early stages of the disease, when there may be some doubt as to whether or not the case is a severe one of measles, of typhus fever, or of influenza.

The practitioner will, of course, bear in mind the prevalence or otherwise of smallpox in the vicinity. He will also note carefully the condition of the patient in regard to vaccination, and he will consider the age of the patient. If the case be one of measles, one of the most helpful things which he can have regard to is the course of the fever during the illness. In smallpox, with the appearance of the eruption on the third day, the temperature will begin to drop, and the general symptoms for the next twenty-four hours will be greatly ameliorated. With measles, on the other hand, the temperature will remain high. The history of the case should help him to decide between smallpox and typhus fever, pneumonia, or influenza during the pre-eruptive stage, and there should be no difficulty whatever in differentiating after the eruption has appeared. Some confusion frequently arises between the highly modified cases of smallpox and chicken-pox. Here again the condition of vaccination and the age of the patient must be first considered, together with the presence or absence of smallpox in the vicinity, but the distribution and the character of the rash will furnish the safest guide in these highly modified cases of smallpox, concerning which doubt might arise.

In such cases of smallpox the eruption is mainly on the face, wrists, and the arms, very sparse indeed, if at all, on the back. The sequence of its appearance has already been alluded to and its character described. With chicken-pox at corresponding stages the eruption may also be on the face, arms, and wrists, but the bulk of it will be on the trunk, especially the back. In the early vesicular stages, the vesicles are very much more superficial than those of smallpox, resembling blisters from minute scalds. Frequently these vesicles break, leaving in severe cases, and especially when a

child has aggravated it by rubbing the clothing against it, an ashy grey ulcerated surface, not unlike that produced by a burn, larger in area perhaps, and certainly more superficial than the eruptive pock in modified smallpox. The coexistence of the various stages of the eruption will also be noted.

In almost all smallpox outbreaks, numerous instances come under notice in which the smallpox patient has sought the protection of vaccination some time after exposure to infection, and had been vaccinated at some period during the stage of incubation of smallpox. This circumstance has given rise to the not uncommon cases in which vaccinia and modified smallpox are concurrent, that is to say, cases in which the vaccination runs its course, more or less in the normal way, at the same time that the patient is passing through a modified attack of smallpox.

The important question arises as to whether or not it is of use to vaccinate a person after a certain number of days have elapsed since his exposure to infection. As a matter of routine practice, every person so exposed ought certainly to be re-vaccinated at the earliest opportunity, and if that vaccination takes place within three days the patient will probably be altogether protected. If, on the other hand, the vaccination has been delayed for from between the second to the eighth day, the probability is that the attack will be modified, but after nine days it is too late, and the protection cannot be relied upon.

There is, however, something more to be said upon this extremely interesting question.

Dr. Roberts, of the City Smallpox Hospital, as a routine practice, vaccinated 200 patients admitted to the smallpox hospital between the second and sixth days of illness. Two of these cases who were vaccinated before the eruption appeared had concurrent vaccinia and modified smallpox. Two others, vaccinated on the second day of the eruption, ultimately developed vaccination vesicles, the smallpox running a very modified course. These were the only results obtained out of the 200 experimented upon.

It is generally accepted that cases of doubtful diagnosis in which vaccination has been successfully performed are cases of some illness other than smallpox; but in the cases noted there is no doubt as to the diagnosis, and indeed similar incidents have occurred during most of the extensive outbreaks.

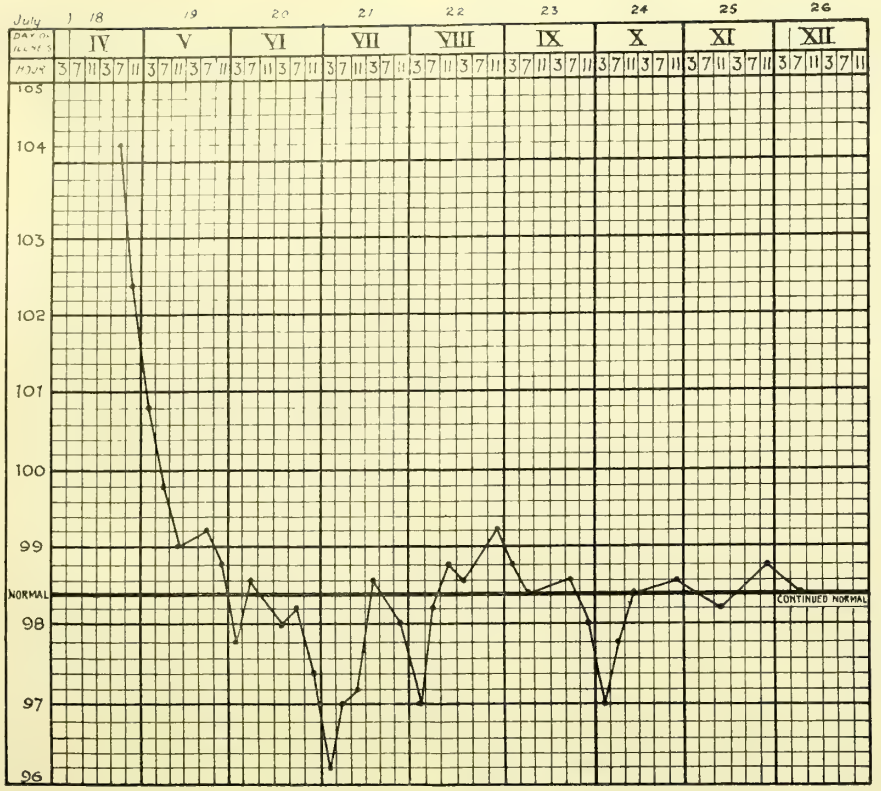
TABLE, SHOWING AGE, CONDITION IN REGARD TO VACCINATION, AND NATURE OF ILLNESS IN 840 CONSECUTIVE CASES OF SMALLPOX.

	Number and Character of Cicatrices.										
	Good.				Indifferent.				Re-vaccinated.	Vaccination doubtful.	Not vaccinated.
Age.	1.	2.	3.	4 or more.	1.	2.	3.	4 or more.			
Under one year .	...	...	1 mild								
	...	...	...	...	...	1 severe	...	...	...	...	4 severe
	...	...	...	...	...	...	...	...	...	...	6 fatal
1 year and under 10	2 mild	5 mild	7 mild	11 mild	7 mild	5 mild	10 mild	5 mild			
	1 severe	2 severe	...	5 severe	6 severe	2 severe	5 severe	...	...	7 severe	45 severe
	...	...	...	...	...	...	...	...	...	...	25 fatal
10 years and under 20	6 mild	22 mild	39 mild	52 mild	5 mild	17 mild	21 mild	28 mild	3 mild[1]	3 mild	
	9 severe	5 severe	6 severe	8 severe	17 severe	13 severe	16 severe	14 severe	...	9 severe	17 severe
	...	1 fatal	1 fatal	...	...	...	...	2 fatal	...	3 fatal	15 fatal
20 years and under 40	17 mild	21 mild	9 mild	4 mild	14 mild	22 mild	16 mild	10 mild	2 mild[1]	1 mild	
	4 severe	21 severe	9 severe	...	27 severe	39 severe	16 severe	1 severe	...	5 severe	10 severe
	1 fatal	1 fatal	...	...	5 fatal	4 fatal	2 fatal	...	...	5 fatal	15 fatal
Over 40 years .	2 mild	3 mild	...	...	5 mild	3 mild	1 mild	6 mild	...	1 mild	
	5 severe	3 severe	...	...	10 severe	9 severe	1 severe	1 severe	...	2 severe	2 severe
	...	...	1 fatal	...	6 fatal	2 fatal	...	...	...	2 fatal	

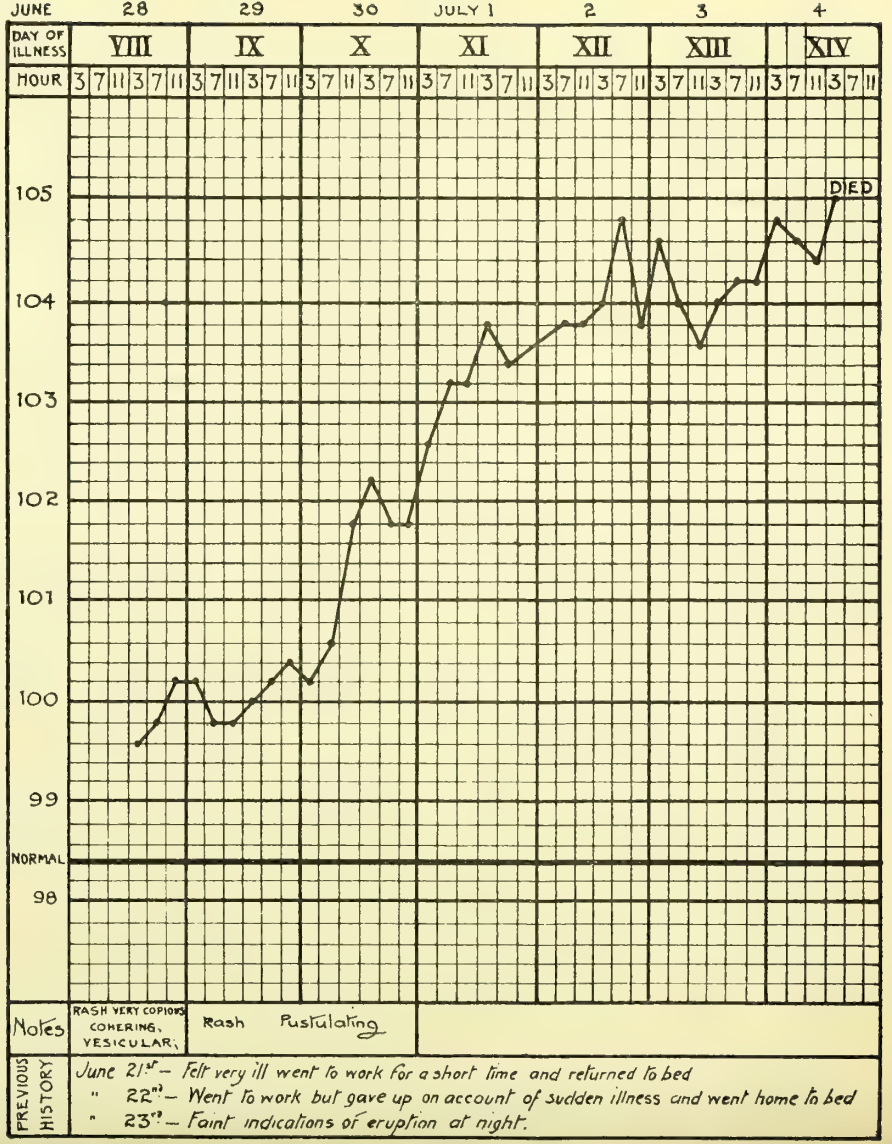
SUMMARY.

		Total.	Died.	Mortality.
Vaccinated	Having one or more good scars	284	5	1·7 per cent.
	Having indifferent scars	374	21	5 6 ,,
Vaccination doubtful (no scar visible)		38	10	26·3 ,,
Not vaccinated		139	61	43·9 ,,

[1] Said to have been re-vaccinated.



CASE VI.

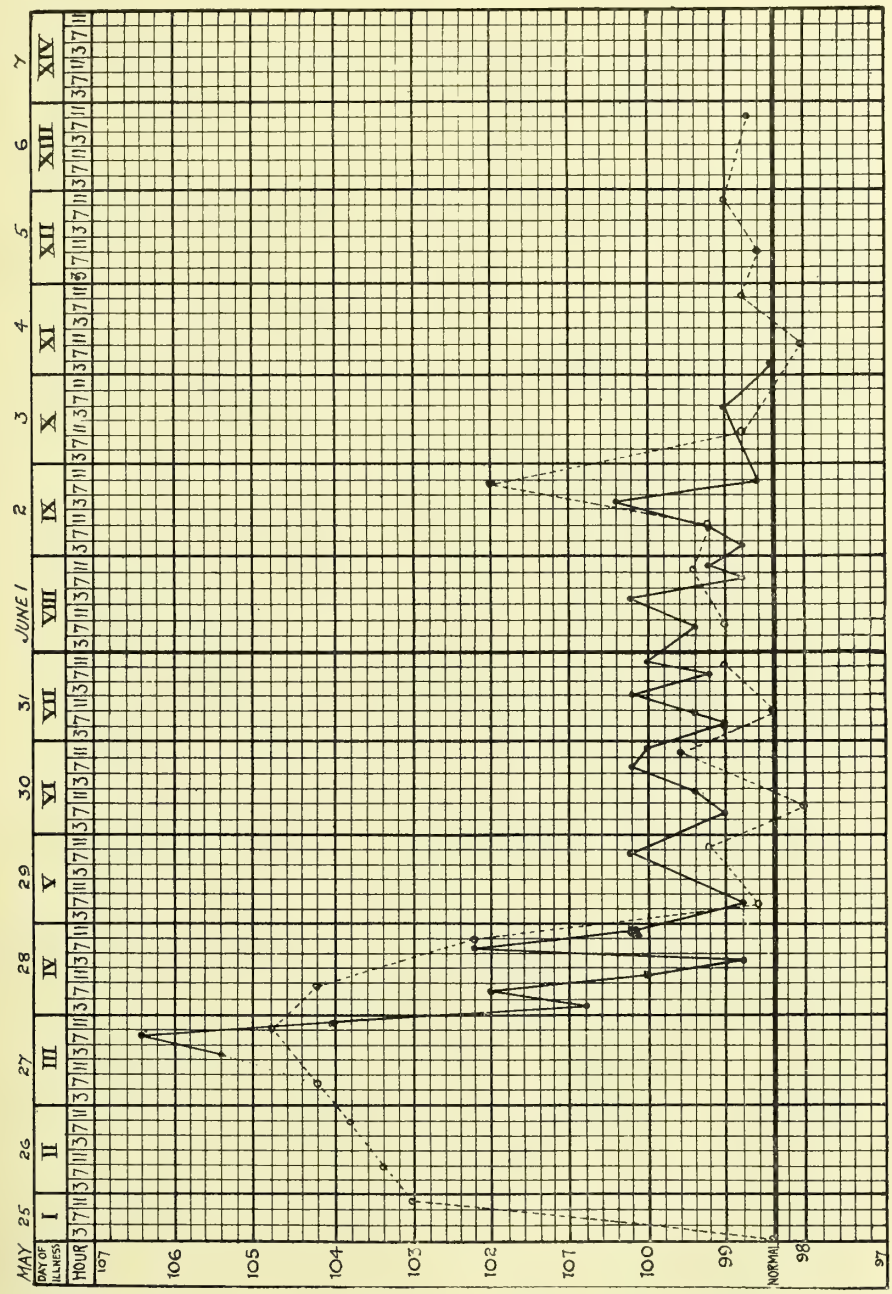


CASE V.

Prevention.—Isolation and disinfection alone would be futile in limiting the extension of smallpox; this was so profoundly felt in pre-vaccination times, that inoculation of the disease itself was resorted to, since experience showed the inoculated disease to be much milder than when contracted in the usual way, and inoculation was accepted in the hope of escaping the ordinary severity of the scourge.

Prevention of smallpox is found in vaccination; the degree of protection depends upon the efficiency of vaccination. This subject is fully dealt with in the article Vaccination (*q.v.*).

Administrative measures of a stringent kind are, however, necessary in limiting the extension of smallpox in this country, on account of the difficulty or indeed impossibility of extending to the entire population the complete safeguard which efficient vaccination affords.

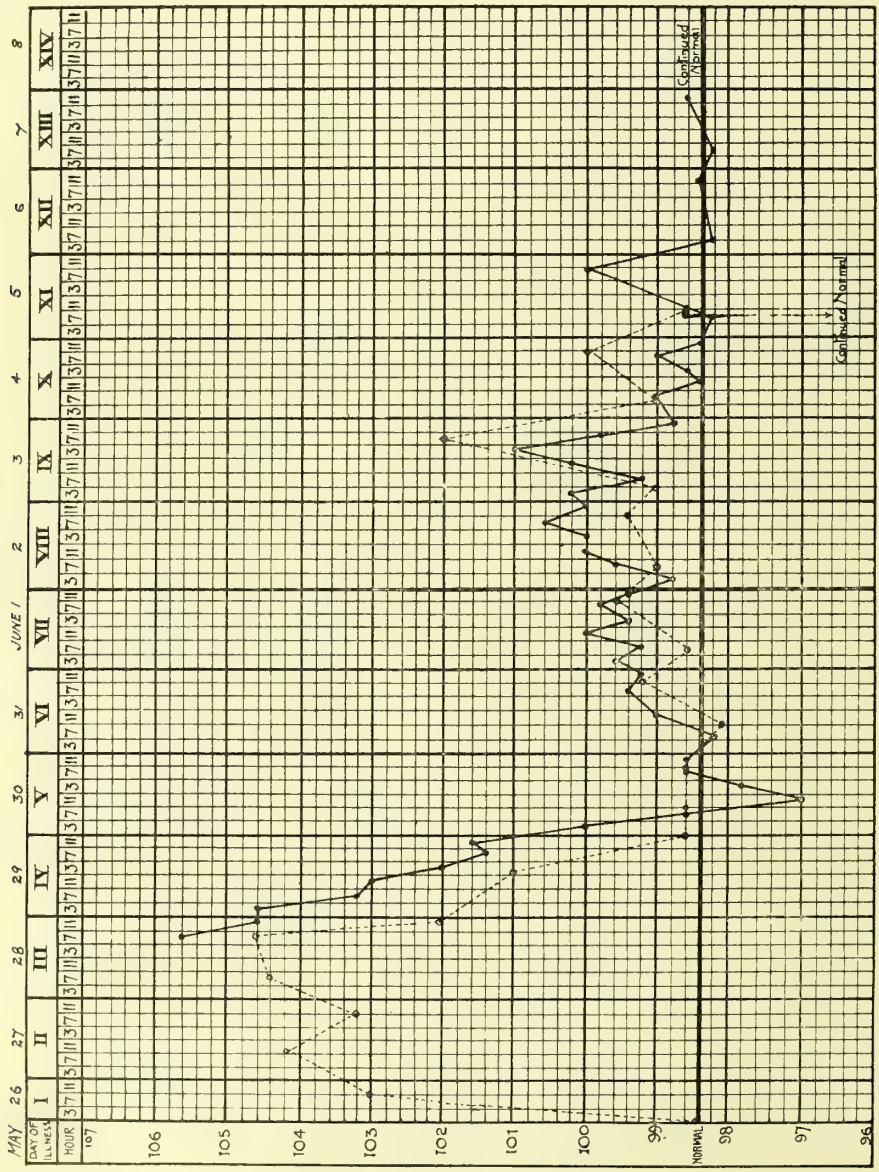


Case VII.

Why is it that smallpox when imported into a district sometimes takes on an epidemic form, attacking, it may be, large numbers of people, and at other times or in neighbouring places at the same time the importation is restricted to a relatively trifling number of people?

It is not improbable that there may be

certain conditions of climate which are more favourable to smallpox than others, but there is no reason to suppose that in these latitudes differences of climate affect the incidence of the disease at all, in fact different outbreaks of smallpox have reached their respective maximum under very varying seasonal conditions.



CASE VIII.

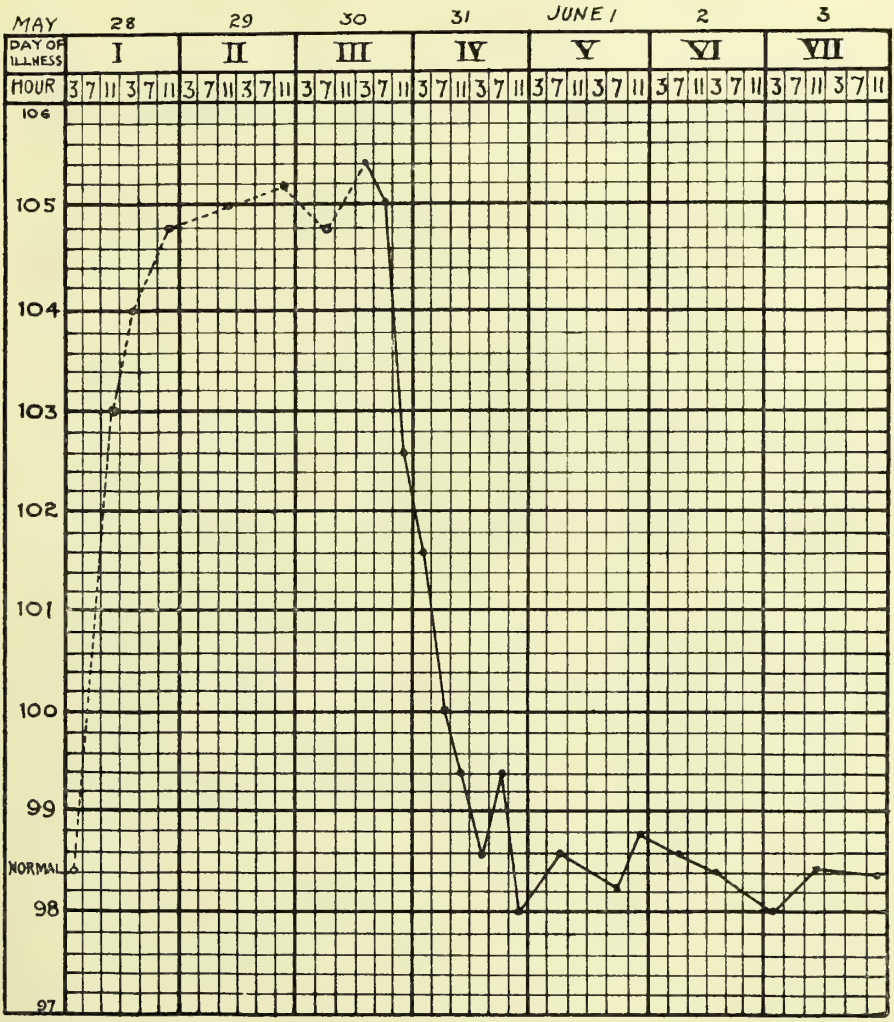
The reason is rather to be sought in the circumstances attending the importations; in cases in which the infected person has by good fortune been in contact only with the vaccinated, and when his illness is discovered at an early stage, and he and all things likely to be infected are promptly removed and dealt with, then it is easy to understand that there would be no extension of the disease; or again, by extreme watchfulness, and by prompt isolation of all those who may have been infected, and revaccinating all who may have been in contact with them, the outbreak will be limited; but such measures are not possible in all cases, and it is easy to understand that if persons whilst actually suffering from smallpox, and from negligence, or from ignorance of the nature of their illness, have followed their usual avocations, or travelled in public conveyances, or even visited places of public entertainment, an extension of the disease must follow; again, instances are frequent in which the patient has lain at home for a time, the children attending school perhaps, adults and lodgers going to their business, the mother dividing her attention between the patient and the shop, infected linen and other articles sent away, visitors

calling at the house; these are the circumstances which sufficiently explain why in the one case the disease takes hold upon a town, and why in another case the outbreak is soon suppressed.

The most careful, patient, and tactful inquiries are necessary in tracing the connections between cases of smallpox, and it is only by these inquiries that fresh cases can be discovered in the early stage, and that missing links in the chain of evidence connecting cases together can

clothing require to be destroyed, a liberal compensation should be paid under the terms of the Public Health Act.

The rooms should be stripped of wall-paper, which is removed and burnt. Special inspectors, experienced in the work, should visit the houses to ascertain precise particulars as to the vaccination of the inmates, visitors, and neighbours, and also endeavour to find out all the persons who have been in contact with the patient.



Case IX.

be found. It is desirable that legislation should impose a penalty upon responsible persons who wilfully withhold information, or knowingly give false information in answer to inquiries made by the medical officer of health.

It is a good routine practice, that whenever a case of smallpox is notified under the terms of the Notification Act, or discovered by members of the staff, the patient should be at once removed to hospital, the house disinfected throughout, the bedding and clothing removed to the disinfecting station. If the bedding and

Notice should be sent to the vaccination officer that the case has occurred, and full particulars of all contacts also sent to him. If any persons living in other towns have visited the patient, information must be at once sent to the medical officer of the district, and notice sent to the school attended by the children (if any), precluding their further attendance. Absentees from school or business, class-mates, or workmates of the patient must be sought, and when necessary notice sent to the employers.

A special effort must be made to induce other

inmates of the house who may be employed in large works or offices, etc., to be re-vaccinated. If they refuse, an intimation should be sent to the employer that it is advisable for them to remain from work for fourteen days.

The infected house must be visited, and all contacts visited every day for fourteen days, and every few days for another period of two weeks, to ascertain if any further sickness occurs; and if any ailment is reported, a medical officer should visit the sick person forthwith, to ascertain the nature of the illness.

A special staff ought to be employed exclusively for smallpox in regard to ambulance, disinfection, etc.



FIG. 7.—Simon M., aged 28. Twelfth day of disease. Represents the customary severity in an unvaccinated man.

It must always be remembered that the patient is infectious from the commencement of the illness until the final removal of all signs of scabbing and scaling; in fatal cases the cadaver is highly infectious, and the coffin enclosing it should be packed with disinfectant and conveyed direct from the mortuary to the grave, or to the crematorium.

Smallpox Hospitals and Isolation Houses.—Some circumstances in connection with hospitals for the isolation of cases of smallpox call for observation.

Site.—The site of the hospital is an important matter. This should be remote from dwellings, highways, public footpaths, and places of public resort, and it should be altogether independent of the hospital for other forms of infectious diseases.

These requirements make the selection of a site difficult, more especially as a large area of vacant land is necessary around it, approximately within a radius of 400 yards or upwards.

It must be remembered also that means must be taken to prevent future encroachments upon this land by dwellings or buildings likely to attract people to the vicinity.

Construction.—The hospital should be constructed upon the pavilion system, and in conformity to the well-known principles in regard to lighting, ventilation, cubic and floor spaces, etc.; it should contain a liberal margin to allow of the isolation of suspected cases, and it is also necessary to make provision for the temporary accommodation of persons who have been in intimate contact with the patient before removal. Hence a city, say of 250,000 inhabitants, should have always available not less than 50 beds for the appropriate isolation of the incidental cases of smallpox which are liable to be imported into such a town, as well as those who have been in immediate contact with them, and also for the accommodation of suspected cases; and it is not less necessary that means of providing more extended accommodation should be available to meet emergencies which may arise.

Administration.—With regard to the admin-



David L., aged 29. Vaccinated in infancy; two good marks. Sixteenth day of disease.



Charles R., 28 years. Vaccinated in infancy; one good mark. Re-vaccinated 26th February 1902. Successful.

James W., aged 37. Vaccinated in infancy; two good marks. Fourteenth day of disease.

FIGS. 8 and 9.—Illustrations of smallpox modified by vaccination in infancy.

istration of a smallpox hospital, there are points requiring attention in addition to those common to ordinary hospitals for infectious diseases. Perhaps the most important are :—

(*a*) The re-vaccination at the time of entering upon their duties of all persons engaged upon the premises, whether regularly or only temporarily at work, and no matter what the character of the occupation may be.

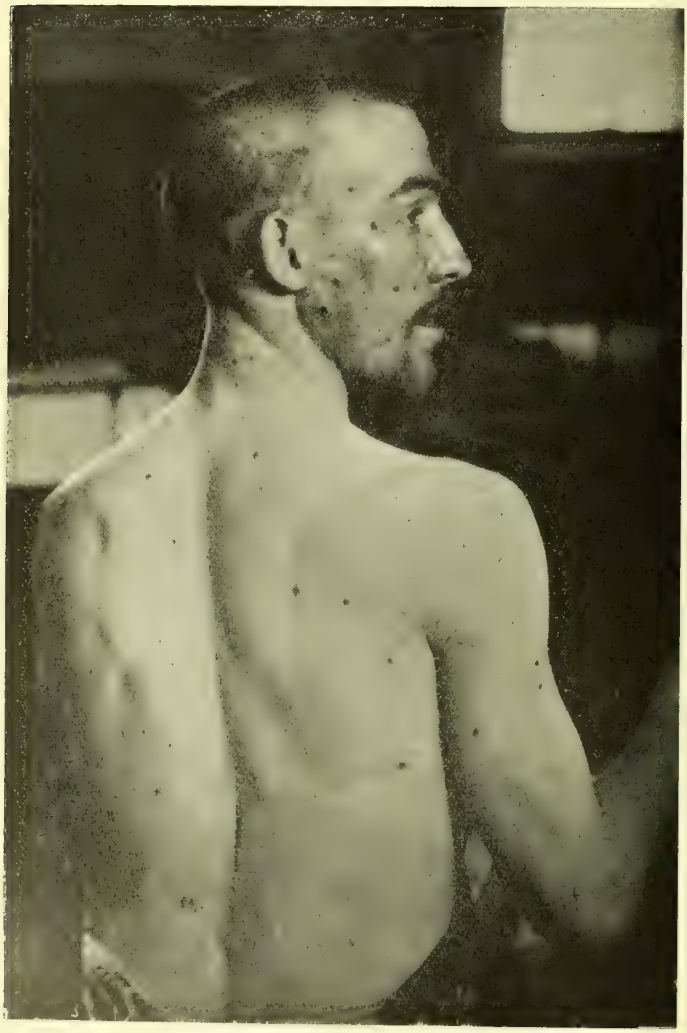


FIG. 10.—Deserves special attention by reason of the typical sparseness of the eruption on the back. A very different distribution to the eruption of varicella.

(*b*) The admission of visitors. It becomes necessary from time to time to admit visitors to patients in the hospital. This should be permitted only under urgent and exceptional conditions, such, for example, as those in which the patient may be *in extremis*. Visits should be minimised as far as possible, and the visitor should be required to be re-vaccinated (unless this has recently been done), to put on suitable hospital clothing during the visit, and to take a good disinfecting bath, and resume his own disinfected clothing before leaving. As an alternative he should be detained in the isolation section for fourteen days after vaccination. Promiscuous visiting is wholly inadmissible. Every information should be given to relatives and friends at a suitable place, in order to avoid the risk inseparable from visits to the hospital.

(*c*) No articles of any kind should be sent out from the hospital, and letters written by patients must be carefully disinfected by dry heat.

(*d*) Nurses and attendants off duty and on leave must take the usual precautions to guard against carrying infection from the hospital. Disinfecting baths should be taken, and clean clothing worn before mixing with their friends or the public.

In many boroughs and small districts the smallpox hospital is an adjunct of the fever hospital, and is controlled from the same administrative block. No doubt this plan is adopted for convenience, and, owing to the rarity of smallpox visitations, the arrangement cannot be altogether condemned in small districts. The expense and inconvenience attending the upkeep of a hospital, for which perhaps for years there may be no use, is not to be lost sight of. At the same time the arrangement is not one to be recommended.

It is a great safeguard to have abundance of room, not only for actual cases of smallpox, but for the isolation of doubtful cases, and for the complete isolation of families from which a case of smallpox has been taken. This latter question leads to the consideration of the provision of special accommodation in quarantine houses where people may be kept under observation. There is clearly an advantage in removing them to wards connected with the hospital, provided that they are willing to go and are well conducted. It is much easier to induce them to go with the patient than to go to another district institution. If the wages of the bread-winners are paid there is usually very little difficulty on this head, and it is far better that this payment should be made than that grave risks should be incurred. There is no special advantage in obtaining large dwelling-houses, and transferring to these dwelling-houses families from which a case of smallpox has been taken. These families can be equally well re-vaccinated and kept under observa-

tion in their own homes in the manner already described.

The great object to aim at is to minimise the means of communication of intimate contacts with the public. It is impossible to remove and isolate all of them, and indeed it is quite unnecessary that such a thing should be attempted.

Care, intelligence, and tact must be exercised in the matter, and it is not difficult to keep the people under observation without rendering that observation in any way irksome.

The following table (X) is interesting, showing the number of cases of smallpox imported into Liverpool during each of the last twenty years, also the number of patients in the city during that period, and the proportion removed to hospital. Table Y shows the cases and deaths during a longer period.

(X) *Smallpox in Liverpool*, 1881 *to* 1901.

Year.	Imported by Sea or Overland.	Reported in the City.	Removed to Hospital.	Percentage Removed.
1881	16	246	199	75·95
1882	7	60	56	83·58
1883	12	114	105	83·33
1884	11	821	743	89·30
1885	11	364	342	91·2
1886	2	232	215	91·88
1887	2	21	23	100·0
1888	9	18	19	73·73
1889	8	1	8	88·88
1890	2	...	2	100·0
1891	10	11	21	100·0
1892	10	167	177	100·0
1893	12	63	73	97·33
1894	6	223	227	99·12
1895	7	130	117	98·15
1896	7	3	10	100·0
1897	2	4	6	100·0
1898	9	8	16	94·11
1899	6	4	10	100·0
1900	32	124	154	98·71
1901	20	17	37	100·0

Treatment. — As already stated, attempts have been made to check the course of smallpox by vaccination after the initial stage and the eruptive stage has been entered upon; these attempts may be regarded as futile, since there is no sufficient evidence to show that any result has followed the experiment. There is no specific treatment to be adopted with a view to cutting short the attack, and the progress and severity of the illness will depend altogether upon the efficiency of the vaccination the patient may have undergone, and the time which has elapsed since its performance.

A careful treatment of symptoms upon general principles will do much towards mitigating the suffering and promoting the recovery of the patient.

From the commencement the patient should be kept in an airy and well-ventilated ward, the temperature of which is maintained at about 60° to 65° Fahr. It is a not uncommon practice to use mattresses of coir fibre, or some material which can be frequently burnt and renewed; horse-hair, however, will be found to be most comfortable; the bedding must not be excessive, the comfort of the patient being the guide. The diet must be one suitable to the patient's febrile condition, and drinks such as water, lemonade, etc., may be given; frequent tepid sponging is valuable in the early stages; headache may be allayed by iced compresses, and vomiting or the tendency to it are frequently relieved by sucking ice or by seidlitz powder. Sleeplessness may be met by bromide of potassium; morphia or chloral must be used with caution, and with careful regard to the patient's condition; in excessive or violent delirium, with flushed face and bounding pulse, the combination of antimonial with the sedative is valuable, but preliminary to their administration the bowels should be well opened by an

(Y) *Smallpox*, 1865 *to* 1901.

Years of Increase.	No. of Cases.	Deaths.	Years of Subsidence.	No. of Cases.	Deaths.
1865	Unrecorded	459			
1866	,,	102			
			1867	Unrecorded	22
			1868	,,	18
			1869	,,	20
1870	,,	174			
1871	,,	1919			
1872	,,	50			
			1873	,,	10
			1874	,,	30
			1875	,,	29
1876	,,	386			
1877	1660	299			
			1878	35	3
			1879	12	
			1880	14	2
			1881	262	34
			1882	67	6
			1883	126	26
1884	832	106			
			1885	375	46
			1886	234	29
			1887	23	1
			1888	27	1
			1889	9	1
			1890	2	
			1891	21	2
			1892	177	13
			1893	75	9
			1894	229	20
			1895	130	12
			1896	8	
			1897	6	
			1898	17	2
			1899	10	1
			1900	156	23
			1901	37	6



FIG. 11.—Alice K., aged 23. This patient has two cicatrices resulting from vaccination in infancy, but the case derives interest from the fact that re-vaccination, performed eight days after inception of smallpox, ran its course and evidently modified the disease.



FIG. 12.—William T., aged 18; tenth day of disease. No marks; unvaccinated.

aperient. As the disease progresses and the eruption appears in unvaccinated patients, the more complete rest the patient has the better are his prospects of recovery; daily tepid sponging and daily change of linen are necessary, but it is not good to sponge frequently, nor to give him frequent baths, these in severe cases appear to aggravate his condition and to promote and increase suppuration; pain from the eruption, for example on the hands, may be relieved by cold compresses; to prevent pitting, various applications to the face have been tried, *e.g.* collodion, ointments, such as those of oxide of zinc, mercury, or boracic acid, painting with iodine; also evacuation of contents of pustules, but none of these has any permanent effect. The oily ointments are most soothing, and appear to hasten the processes of maturation and desiccation, but if one half of the face is treated in either of these ways, and the other half left alone, the ultimate results are the same.

Throughout the illness strict attention must be given to dieting; the nourishment which the patient can assimilate will usually be in a liquid form, and the administration of wine or brandy will be governed by his condition.

Delirious patients must be carefully watched to avert accident.

During convalescence, tonics, as quinine, are useful, and at this stage baths are of the utmost value, and facilitate the scabbing and scaling processes. Boils are common, and must be treated surgically. Small ulcers at the edge of the cornea are frequent at this stage, and usually get well if a little powdered calomel is blown into the eye.

The mild forms of modified smallpox call for no special treatment.

Smedley's Paste.—Smedley's Chilli Paste is believed to have a constitution somewhat similar to the *Unguentum Capsici* of the British Pharmacopœia. *See* Capsici Fructus.

Smegma.—Sebum, especially that secreted by the sebaceous glands of the prepuce. *See* Penis, Surgical Affections of the (*Balanitis*); Tuberculosis (*Diagnosis of the Tubercle Bacillus from the Smegma Bacillus*); Urine, Bacteria in (*Tubercle and Smegma Bacilli*).

Smell. *See* Nose, Examination of (*Senses of Smell and Taste*); Nose, Nasal Neuroses (*Neuroses of Olfaction*). *See also* Brain, Physiology (*Sensory Centres, Smell; Cranial Nerves, Olfactory*); Brain, Tumours of (*Localising Symptoms, Smell, Anosmia*, etc.); Children, Development of (*Smell*); Ear, Middle, Chronic Suppuration of (*Symptomatology, Taste and Smell*); Fifth Nerve, Affections of (*Affections of Taste and Smell*); Hypnotism (*Experimental Phenomena, Special Senses*); Hysteria (*Sensory Disorders*); Mind, Education of the (*Education of Sense of Smell*); Paranoia (*Progressive Systematised Insanity, Hallucinations of Smell*); Pregnancy, Affections and Complications (*Nervous System, Perversion of Smell*).

Smellie's Forceps.—Midwifery forceps furnished with the typical British or Smellie lock; at first Smellie used *short* forceps, but in 1751 he added the pelvic curve, making the instrument *long*. *See* Labour, Operations (*Forceps*).

Smellie's Scissors.—A perforating instrument used in the obstetric operation of craniotomy. *See* Labour, Operations (*Embryotomy*).

Smelling Salts.—Ammonium carbonate with some aromatic substance added to it. *See* Ammonium and its Salts (*Carbonate*).

Smilax Ornata. *See* Sarsaparilla.

Smith's Cramp.—An occupation neurosis of the arms occurring in smiths or hammermen. *See* Neuroses, Occupation (*Hephæstic Hemiplegia*).

Smith's Fracture.—Fracture (transverse) of the radius about two inches above its lower end.

Smith's Gag. *See* Palate, Cleft (*Operation, Instruments*).

Smith's Palsy. *See* Smith's Cramp.

Smoke-Test.—A method of testing whether the drains of a house are leaking or not; smoke is forced into the drains by a generator, and its escape at any point in the course of the drains indicates the position of the leak.

Smut.—A fungus (*Ustilago segetum*) found sometimes in flour or meal.

Smyrna. *See* Balneology (*Turkey*).

Snake-Bites and Poisonous Fishes.

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See also Immunity (*Natural Resistance to Poison*); Purpura (*Toxic*); Therapeutics, Serum Therapy (*Antivenene*).

From very early times there has been a common belief that certain people had a peculiar power of freely handling venomous snakes, and that a measure of resistance to the poison was

acquired. Some of these "snake men" are not only described in old records as being immune to the poison, but also as having a remarkable influence over the snakes themselves; it was popularly supposed that snake blood flowed in their veins.

In present times it is well known that some men exhibiting snakes in India frequently rub in small quantities of the venom on the back of one hand with the other, a small part being probably absorbed. In South Africa the Hottentots are said to eat the heads of poison snakes when killed.

Serpents were very generally worshipped by ancient man; their great beauty, grace of movement, and frightful power of causing rapid death by injecting venom, or by crushing, appealed strongly to the superstitions of the people, who either associated them with death or wisdom.

This serpent worship was almost universal, and was nowhere more prevalent than in India, where even in the present day the cobra is held in very great veneration, and it is never willingly killed by the Hindoos. In pre-Buddhist times, that is, about 600 B.C., the gods were represented with a canopy of five or seven cobras over them (Naja figures), and in the old cave temples very beautiful relics still remain showing these. In Southern India a single cobra is frequently represented alone. It is also one of the symbols of Shiva now.

In Egypt the old papyrus records show that snakes were divided into two classes: one, generally the cobra, being associated with divinity and symbolising wisdom; the second representing the malign influences and death, depicted as the serpent "Apep," the emblem of darkness, and the enemy of "Ra," the sun.

In China these beliefs take a more practical form, the concretions, etc., of snakes finding a prominent place as therapeutic remedies. Traditions of the same kind have been passed down from mediæval days to witches, etc. (vide *Macbeth*).

Many curious powers are attributed to snakes beyond the mesmeric influence they exert over their victims before springing upon them. Thus a "krait" or species of *Bungarus* found in Scinde is called by the natives there "pyan," or drinker. This snake is said to suck in a man's breath when he sleeps, the result being that he dies at sunrise, with a swollen face, but no mark of a bite on him. No one will sleep on the ground for fear of the "pyan" in this district. The natives, however, admit that it can bite, but rarely does.

Venomous snakes are divided into two main classes—(1) Colubrine, (2) Viperine.

The Colubrine again into (1) Elapidæ, or land snakes. (2) Hydrophidæ, or sea snakes.

The Elapidæ include—

(1) *Naja*, or Corbas, found in India, China, and N. Africa.

(2) *Ophiophagus*, or Hamadryads, found in India and East Indies.

(3) *Bungarus*, or "Krait," of India.

(4) *Hoplocephalus*, or Tiger snakes, etc., found in Australia.

(5) *Pseudechis*, or Black snake, found in Australia.

(6) *Acanthophis*, or "Death Adder," found in South Africa and Australia.

(7) *Elaps*, or "Coral snake," found in West Indies and Brazil.

The Hydrophidæ include—(1) *Hydrophis*, (2) *Enhydrina*, (3) *Pelamis*, (4) *Platurus*, (5) *Aipysurus*.

The poisonous Viperine snakes are divided into—

(1) Viperidæ, or true vipers.

(2) Crotalidæ, or pit vipers.

The most important of the former are—

(1) *Daboia*, or "Tic-polonga," "Russell's viper," of India and Ceylon.

(2) *Echis*, or "Fursa," of Northern India.

(3) *Cerastes*, or "Horned viper," of Egypt.

(4) *Pelias*, or "Common adder," of Europe.

Of the latter are—

(1) *Crotalus*, or "Rattlesnake," of America.

(2) *Bothrops*, or "Fer de Lance," of West Indies.

(3) *Halys*, of India.

Geographical Distribution. — Poisonous snakes are found in all tropical areas, except certain oceanic islands, and in most temperate ones, New Zealand being a marked exception.

Each region has, however, distinctive characters.

In Asia and Africa the cobras, hamadryads, kraits, and true vipers are most abundant.

In America the Crotalidæ.

In Australia the pit vipers are not at all represented. Krafft states that twenty-one innocuous and forty-two venomous snakes occur there, but of the latter only five are dangerous to man; these include *Hoplocephalus*, *Pseudechis*, and *Acanthophis*.

In South Africa, chiefly the Acanthophis, or Death adder.

In the West Indies, *Elaps* and *Bothrops*.

The *Mortality* from snake-bite in India is very high, being even now put down as about 20,000 annually, equal to about 1 to 10,000 of the population.

In Australia the death-rate proportionately is considerably less—probably, as Martin states, due to the people having a much better knowledge of what to do.

The most deadly snakes in India, according to Fayrer, being in order of severity of action—(1) Cobra, (2) Kraits, (3) Daboia, (4) Echis.

In Australia *Hoplocephalus curtus*, *H. superbus*, and *Pseudechis* are the worst. The sea snakes rarely attack man, though so common in Australia and waters of the Far East.

Anatomical Characters.—The "true vipers"

are distinguished by their triangular-shaped head and constricted neck; the scales on the head are generally small, the loreals (scales between the nasal and anterior ocular) are almost always wanting. The pupil is vertical; the fangs are tubular, large; reserve teeth being present, but no others are found on the short maxillary bones; the tail is rapidly attenuated.

The "pit vipers" have triangular heads, but with large scutes on the top; otherwise, as in the true vipers, the poison fangs are very large, the maxillary bones are small and very movable, and the tail ends in a rattle or hard spines.

The poisonous *Colubrine* have smaller heads of regular shape; the scutes on the top are generally well marked and regular; the "loreals" are usually absent; the maxillary bones are longer, less movable, and the fangs smaller than in the vipers, and they are grooved along the anterior border and not tubular. The pupil of the eye is generally round, and the tail gradually tapers to a point.

The *Hydrophidæ*, or sea snakes, have small heads, with the nostrils on the upper surface. The anterior frontal scutes and loreals are absent, the pupils are round, the ventral shields are usually absent, and the tail is flattened from side to side, the tongue is short, and the poison fangs are small and grooved.

The great distinction between non-venomous and poisonous snakes is that the former possess two complete rows of small ungrooved teeth on either side of the upper jaw, the outer row, twenty to twenty-four in number, being attached to the maxillary bones, the inner to the palatine; when they bite they leave characteristic marks.

In poisonous snakes the outer row is represented by one or more tubular or grooved fangs, firmly ankylosed to the maxillary bone, which is freely movable; this mobility allows the erection and depression of the fangs. The anterior is always the largest, the others, if present, being reserve teeth. When these snakes bite, they leave usually two punctures only.

The *Venom* is secreted by a compound racemose gland, which Günther describes as being homologous with the parotid glands of mammals, having large alveoli which act as receptacles for the fluid; these glands are placed behind the orbit above the angle of the mouth; they are invested with a dense fibrous sheath, being also covered by the masseter muscles. The excretory duct passes forwards, opening into the base of the sheath of mucous membrane covering the fang, being here bent at an acute angle, so as to face the front border of the tooth, thus allowing the fluid to flow freely down the tube or groove as the case may be. When the snake opens its mouth to bite, the muscles act on the maxillary bones and erect the fangs; as the jaw closes on the part bitten the masseter and pterygoids compress the poison glands so that the venom is forced down the duct into the tooth and injected into the wound. The firmer the hold obtained, the greater the quantity of venom injected, and the greater the danger.

Non-poisonous snakes also have rudiments of this gland, which secretes a poison not in sufficient quantities to be harmful, but sufficient to render them resistant to the toxic effects of other poisonous snakes when bitten. (Fraser.)

In 1896 Prof. Fraser asserted that the serum of poisonous snakes possesses antitoxic powers, and presumes that this was acquired by the snake swallowing its own venom. Cunningham later disproved this, showing that the natural immunity of the snake is quite distinct from the artificial immunity which is established in other animals as the result of continued cumulative treatment by cobra venom, and that it is unconnected with any material of the nature of an antitoxin. He found that cobra serum had *no* antidotal effect on Daboia venom; he does not therefore believe that the immunity of snakes is due to the swallowing of their own venom.

The fact, however, remains, that most reptiles and amphibians possess a high degree of resistance as a natural property, quite independent of any process of self-protection. One of Cunningham's snakes readily resisted an amount of cobra venom enough to kill one hundred fowls, yet its serum had no protective power; its blood indeed was highly toxic for one week after, enough to rapidly kill a fowl when injected.

The immunity of snakes to venom of other and the same species is not absolute, though general, for I have seen a *Daboia russelli* in captivity attack a second in the same cage, which was found dead soon after. Also any one who has seen a fight between a hamadryad and a rat snake "Dhamin" of equal or larger size will remember the gradual poisoning of the latter, which nevertheless meanwhile inflicts much local injury on the less powerfully toothed but successful adversary. A species of *Bungaras* or "krait" of Scinde will kill and swallow the very venomous "fursa" or *Echis carinata*. Cunningham further believes that the degrees of susceptibility to some extent run parallel with the respiratory acquirements, the slow-breathing, hybernating reptiles and lizards having the greatest resisting power. The mongoose is remarkably resistant to cobra poison, requiring from 10 to 25 times as much venom per kilo as a rabbit to produce lethal effects Elliot believes that the success of this animal in fighting cobras depends on (1) its great agility; (2) its habit of "setting up" its fur, thus deluding the snake as to the vulnerable part. Its immunity is due to the habit it has of seizing the snake by the head, and often by so doing incising the gland with its sharp teeth, causing the venom to escape and be swallowed by the mongoose; this would also reduce the

possible amount to be injected down the fang. Then there is the inoculation of minute quantities of venom from repeated, but ineffectual, scratch-bites. In these ways a partial immunity, which is hereditary, is established, becoming lost in time if the animals be removed to countries where cobras do not exist.

Other creatures are slightly immune, as pigs and guinea-fowl; the latter, according to Calmette, being to a slight degree protected by having large air sacs. It has lately been shown by Calmette and others, that the resisting power to venom becomes greater the larger the animal; thus it takes a much smaller dose of venom proportionally, volume for volume, to kill a rabbit than a dog, man being even more resisting.

Venom is obtained pure from the different poisonous snakes by either making them discharge the fluid direct into a watch-glass, this being assisted out by gentle pressure applied to the poison glands, the snake being held in the hand with its head directed away from the operator as described by Calmette; or the venom may be obtained by causing the snake to bite at a watch-glass covered with gutta-percha, the fluid collecting on the under side. The venom should be taken from a fasting snake every two weeks or so. From a good-sized cobra about 2-3 c.cm. is the average quantity obtained by Calmette, after which he generally artificially feeds the snake.

The venom thus collected has much the same appearance in all snakes—a limpid fluid of yellowish colour; from the cobra it is a faint yellow, that of the hamadryad being a golden yellow; it has a slightly acid reaction and an average specific gravity of 10·50; a bitter taste is said to be present in the venom of the cobra, but not in that of the Daboia. When the venom is placed under the microscope nothing should be seen except a few epithelial cells and perhaps some contaminating bacteria. When kept moist it gradually becomes more acid and decomposes, forming a coagulum, the fluid part remaining poisonous.

Venom, when dried at a moderate temperature, 20° C., forms reddish-yellow or brownish-yellow crystalline scales, or it becomes agglutinated into little masses like gum-arabic. When thus dried and kept in the dark it retains its toxic powers indefinitely. The dried residue equals in weight about 20-30 per cent that of the moist venom. If the venom be heated at once after collecting, to a temperature of 100° C., its toxic effect becomes impaired, and also if it be exposed to light.

The poisonous properties of *all venoms* depend upon the presence of at least two distinct toxic proteids. These proteids are similar to other albumoses produced from albumens, which may have been obtained by

(1) Boiling under high pressure.

(2) Gastric and pancreatic digestion through the agency of a ferment.

(3) The direct vital activity of cells.

(4) By certain micro-organisms, as *Bacillus diphtheriæ*, *B. tuberculosis*, and *B. anthracis*; by means of a ferment in the case of diphtheria, but by the direct action of the other two.

The proteids of venom are elaborated by a process of dehydration of albumen, without the action of any ferment by the epithelial cells of the poison glands, the ultimate product stopping short at the albumenose stage, not proceeding to the production of peptones, as occurs in all the before-mentioned, except the toxin produced by diphtheria (Sidney Martin). In all cases, however, these albumoses, though differing greatly in intensity of action, yet when gaining access to the blood produce certain toxic effects, hence the antitoxic principle which now underlies the treatment of snake-bite, etc. The poisonous properties of peptone are becoming much more recognised through the work of Prof. Wright and others; it is an important fact to deal with in the preparation of antitoxic and prophylactic serums.

It has been shown by Martin and Gavan Smith that when dried venom is heated, it separates out into an albumen coagulated by heat, 70°-80° C., and a filtrate non-coagulable at any temperature, its action being, however, destroyed by boiling.

It has been further shown by Calmette that the albumen thus coagulated out has little toxic power, but that the filtrate, when dialysed out in a current of sterile water for twenty-four hours, gives a solution which, on being dried *in vacuo*, forms a brownish amorphous powder forty times more toxic than ordinary venom.

The amount of coagulable and non-coagulable proteids varies in amount and proportion in different classes of snakes; thus in the Colubrine there is a large amount of non-coagulable poison, in the Viperine there is a very considerable quantity of the coagulable; on this difference depends to a large extent the variation of the symptoms produced by individual snakes. This is nevertheless only one of degree, as the *toxic effects of the non-coagulable poison are very much the same in all*, acting principally on the nerve centres, producing death by paralysing the respiratory centre in the medulla. The coagulable proteid acts chiefly on the blood-vessels and heart, being a powerful local irritant.

Cobra poison, which, as before stated, is rich in the non-coagulable proteid, kills by producing asphyxia, the heart beating after respiration has stopped; hence the use of artificial respiration in the treatment.

Rattlesnake venom is rich in the coagulable proteid, producing disastrous effects on the blood-vessels and heart.

Australian snakes show a good deal of both, and have an intermediate action.

Sir Joseph Fayrer found that cobra venom killed without destroying the coagulability of the blood, whilst Daboia (viper) poison caused complete and permanent fluidity, the blood of the animals so killed being excessively toxic.

Cobra poison produces little change in the pupil, Daboia widely dilates; salivation is a constant symptom of the former, rare in the latter.

When experimenting with venoms, Calmette and others at Lille use only the non-coagulable proteid, by which means they get rid of the intense local reaction of the second proteid; and as the *chief* toxic properties are in the former, the physiological effects of the venom are better thus watched. He also at once mixes up the venoms of all his snakes, from the sum total of which he obtains his dried toxin for experimental purposes.

It has been found that the non-coagulable filtrate of all venomous snakes, whether Viperine or Colubrine, has, when injected, the same characters and gives rise to the same symptoms.

The rapidity of the onset and the severity of the case depends on whether the virus is injected direct into a vein or into the subcutaneous tissue. It is rarely absorbed by healthy mucous membranes, but Fayrer is strongly adverse to the practice of sucking cobra bites. Also, recently ejected venom acts as a powerful local irritant when applied to the conjunctiva, and may be absorbed.

The question of absorption and the neutralisation of venom by the various secretions of the body is of great interest, having been specially studied by Prof. Fraser and Capt. Elliot, I.M.S.

Martin states that gastric digestion does not affect cobra or Pseudechis venom. Mitchell says it does that of the rattlesnake. Fraser found that snake venom introduced by the mouth was not followed by any bad results. This was either due to non-absorption or to chemical changes produced there by the gastric secretions. The latter was disproved by finding that after removal it still retained poisonous properties when injected into the blood. He next found that by mixing bile with the venom it was rendered innocuous.

Elliot has since, by experiments on dogs, proved that after diverting the bile completely, venom given by the mouth was still innocuous, but that if introduced into the small gut, it was rapidly absorbed through an unbroken epithelial surface, causing death. He concludes

(1) That cobra poison can be absorbed through the mucous membrane of the small gut, though not so readily as when injected in the subcutaneous tissues.

(2) That some change is induced in the swallowed cobra venom before it reaches a rapidly absorbing surface.

(3) That though bile is powerfully antidotal, as proved by Fraser, yet it is not the only protective agent.

(4) That trypsin is very powerful in reducing the lethal properties of cobra venom. Martin states that *all* venoms are destroyed by pancreatic digestion.

The result of all venoms is at first to produce a rapid fall in the blood pressure, during which the animal may die; if not, the blood pressure again rises, going above normal, as occurs after the injection of toxic peptones. In cobra poisoning the blood pressure may remain high until the time of death, even during the asphyxial period; if artificial respiration is then efficiently carried out, convulsions are prevented and life may be saved.

Lauder Brunton and Fayrer concluded that, besides paralysing the reflex activity of the cord, the poison acts on the nerve endings in the muscles like "curare." In the poisoning by vipers and Australian snakes, the dyspnœa and fall of the blood pressure occur together; but though producing the same paralysis of the reflexes of the cord, they *do not* especially select the respiratory centre. In these cases, therefore, artificial respiration is usually of little avail.

The action of venom on the blood has been shown by Martin and Halford to cause a rapid destruction of the red corpuscles, the leucocytes being relatively increased in numbers, these very quickly degenerating, their vital activity being destroyed. Martin placed two small pieces of sponge antiseptically in the abdominal wall of a guinea-pig, one having been soaked in a neutral saline solution containing 1 per cent of venom, the other in the solution free from venom; œdema occurred around the sponge containing the venom. After five hours the animal was killed. Both sponges were withdrawn, hardened, and sections made from them. In the first, healthy leucocytes were only found at the periphery, broken down ones filling the interior; in the second, the whole was permeated with healthy phagocytes.

Calmette, from his experiments, finds that the venom does not act directly on the nerve-cells of the brain, but on the leucocytes, and that it is carried by them to the bulbo-medullary centre.

The rapidity with which venom acts depends on

(1) The quantity injected.

(2) The rapidity of absorption.

(3) The condition of the snake at the time of the bite.

(4) The susceptibility of the animal; the personal factor, as pointed out by Elliot, being very important.

A minimum lethal dose always takes a considerable time to produce its results, and, as the amount injected is generally small, there is frequently time to apply remedial measures.

Calmette gives the toxicity of venoms according to their virulence, based on the number

of grammes of an animal killed by one gramme of poison, as

Cobra, 4,000,000.
Hoplocephalus, 3,450,000 (4,000,000 Martin).
Pseudechis, 800,000 (2,000,000 ,,).
Common Viper, 280,000.

Sir J. Fayrer believes that a full dose of venom from a cobra, hamadryad, krait, or Daboia is necessarily fatal. It is only in cases where an amount little above the minimum lethal dose has been injected that remedial measures are of any use.

The Effects of Heat and Chemical Agents.—A temperature of 100° C., if prolonged, will modify or destroy any snake venom, even after the removal of the coagulable proteid.

A 10 per cent sol. of caustic potash or soda, after being in contact five or ten minutes, diminishes the poisonous properties of the virus.

A 1 per cent sol. of pot. permang. destroys one part of venom when in contact, but its action is unreliable.

Hypochlorite of lime, 1 in 60 of water freshly made up, destroys the venoms completely, as also does 1 per cent of chloride of gold. The latter two are the only ones recommended by Calmette, and are generally accepted now as being the best.

Symptoms.—These are very varied, according to the character of the snake and the amount of venom introduced, but depending greatly upon the presence or absence of the coagulable proteid.

Cobra.—If the amount injected be very large, death may follow very rapidly as if from shock —due to paralysis of the cardiac ganglia. When introduced in smaller quantity, and slowly absorbed, it produces some local redness and œdema, with progressive weakness and general paralysis, but showing a great preference for certain centres, particularly those governing the tongue, lips, and larynx, causing inability to swallow and profuse salivation; respiration is rapidly extinguished with or without convulsions, and finally the heart stops, the pupil is contracted but reacts to light, the urine is never albuminous. If the symptoms pass off, complete recovery is rapid. When the poison is injected in a maximum lethal dose, stimulation of the centre produces violent convulsions, especially respiratory spasms, followed by general paralysis and rapid death.

European Viper.—Very quickly after the bite there will be local pain and swelling of the part, with general prostration, feeble pulse, perhaps passing into a condition of semi-coma or delirium, with slight convulsions. Recovery is generally rapid, though local suppurations not infrequently follow.

Daboia and Indian Vipers.—In these there is marked local inflammation at the seat of the bite, with swelling of the limb, great pain, and hæmorrhages. Violent convulsions soon set in, but not necessarily followed by general paralysis and death. The paralysis does not especially select out the respiratory organs as in the case of cobra poisoning. The breathing has a peculiar irregular character, being at first quickened, then slowed. Hæmorrhages from the mucous membrane are common, hæmaturia and albuminuria being almost always present. The pupils are generally dilated and insensitive to light.

Rattlesnake.—The symptoms following the bite of one of these snakes are much like those produced after a bite from the Indian vipers, except that the local symptoms are more marked, general symptoms of blood-poisoning being after a short time evident. Recovery from an almost hopeless condition is sometimes extraordinarily rapid.

Australian Snakes.—In these, according to Martin, local pain and swelling of the part bitten is not generally severe. The constitutional symptoms come on from a quarter to half an hour after the bite, with faintness, drowsiness, and prostration; the pulse gets thready, respiration becomes very slow, hæmorrhages and albuminuria are generally present, the comatose condition gets deeper and deeper, respiration stopping, then the heart.

Sea Snakes.—Although all these are poisonous, they rarely attack man. I have seen scores taken by careless sailors on the north-west coast of Australia, etc., without any bad results. Several instances of fatal bites have been recorded, one having caused death in 1¼ hour.

The most fatal period after all bites appears to be between two and three hours; more than 25 per cent die between one and three hours.

Treatment.—When a person has been bitten by any snake supposed to be venomous, the first and very important measure is to prevent the entrance of the virus into the general circulation. As the part bitten is generally one of the extremities, this may often be done by applying a tight ligature at once between the part bitten and the trunk; the second point is to remove or counteract the virus as soon as possible, suck the wound to extract the poison, cut the part out or cauterise freely, then wash the wound well with hypochlorite of lime = 800 parts of chlorine to one of lime, or inject 8-10 cm. of the same in the track of the bite; this destroys the venom *in situ*, neutralising that not yet absorbed, or a solution of chloride of gold would act equally as well.

Inject 10 to 20 c.c. of antivenine if obtainable into the subcutaneous tissue of the flank, or if general infection is marked give it intravenously; after this has been done the ligature may be removed. One should also promote warmth, stimulate the circulation, and carry on artificial respiration if necessary. If no antivenine is to be had, give stimulants freely.

Half the number of fatal cases are stated to die from fear, not having the heart at the time to apply any remedial measures (Krafft).

Serum Therapy

The analogy between certain toxins produced by pathogenic micro-organisms, as diphtheria, tetanus, etc., and the products of snake venom, together with the effects that they produce on most mammals, led to the belief that some antitoxin might be prepared for the latter, which would give protection against the virus. In spite of the opinion of Sir J. Fayrer and others that any idea of finding a physiological antidote was utopian, it has to a great extent been actually accomplished: the preparation and dispersion of a most valuable antitoxin is now being carried on in large quantities by Professor Calmette of Lille and his assistants. There is also to be a special laboratory, under the care of Major Semple, to supply this antivenine on the spot for the use of India.[1]

History.—Sewall in 1886 experimented on pigeons. By very gradual and repeated injections of rattlesnake poison, he produced in them very marked resisting powers to that poison.

Cunningham, by experiments at Calcutta, found that though a fowl may be immunised against cobra bite by repeated injections of the virus, yet that it was not then protected from Daboia poison and *vice versa*, in contradistinction to the statements of Calmette and Fraser, that an animal immunised to cobra poison was also immune from *all* other snake venoms—a doctrine quite contrary to Behring's law, "that the action of an immunising serum is specific."

Phisatrix, Bertrand, and Calmette advanced knowledge a step further. Experimenting with rabbits and the venom of vipers, cobras, etc., they found that not only were they able to immunise the animal itself, but they also found that the serum of these animals had distinct antitoxic powers if administered within an hour of the ingestion of the venom, causing what would have been a lethal dose to be less so or non-effective.

Professor Fraser in 1895 administered large doses of cobra venom into the stomach of a cat, producing no poisonous effects on it; but the cat was found to be immune to the poison when given hypodermically, and that its blood serum had antitoxic properties. He also found that its kittens acquired protection through the milk supplied by the mother.

Snake men are believed to acquire a certain amount of immunity by the repeated inunctions of small doses of venom on the hand, or, in Africa, by eating the head of the snake—at least that is a common opinion held in South Africa. Captain Elliot, I.M.S., from his recent observations in India, brings forward evidence to favour the following conclusions:—

(1) That "snake men" in India, as a rule, have no knowledge of acquiring any immunity, but trust to their own intimate familiarity with the habits of the snakes, or to the previous mutilation of them, by removing their fangs, or sometimes by producing an internal fistula from the poison gland into the mouth.

(2) That a *few* do practise swallowing venom, or the inunction of venom into the limbs.

(3) That they confine their work entirely to the cobra, the Daboia being very irritable, uncertain, and not at all amenable to their charming.

Calmette has shown that the antitoxic properties present in the serum of animals immunised against venom are *not* due to the direct action of the antitoxin on the virus, but that it is exerted through the tissue elements of the animal. He next proved that by mixing the venoms of various snakes, including Naja, Daboia, and Hoplocephalus, etc., and removing the coagulable irritative proteid, using only the active toxin of the dialysed non-coagulable form, he was able to produce an antitoxic serum (from horses) which immunised animals and man from lethal doses of *any* venom, although each snake venom has *per se* well-marked toxic peculiarities producing several and various local phenomena.

In 1898 Major Semple, R.A.M.C., Captain Lyons, I.M.S., and Staff-Surgeon Andrews, R.N., under the supervision of Professor Calmette, by a very complete set of experiments demonstrated that antivenomous serum could be prepared from horses which had a very high antitoxic power; that its preservative action shows itself almost instantaneously when injected intravenously, but if injected subcutaneously, only after a period of one to three hours; that under certain conditions it acts as a vaccine. They also proved that the duration of immunity so produced is short; the greater the quantity of serum injected, the longer this immunity remains. Its principal characteristic was its rapidity of action and its efficacy against all venoms, whether from Colubrine or Viperine snakes. They found that this antivenine is easily kept, as it does not lose its protective properties when heated to 140° F.

This antitoxic serum is prepared in the following manner. Injections over the shoulder were given to healthy horses subcutaneously of a solution of dialysed venom in increasing doses for a period extending over months, generally sixteen, each injection usually producing severe local reaction and abscesses. When the horse is sufficiently immunised, he is bled from the jugular, the blood is kept in a dark room for twenty-four hours, after which the serum is syphoned off, divided up into 10 c.c. bottles; these are sterilised at a temperature 10° C. on three successive days, the bottles being kept in

[1] This laboratory is now in active existence.

a dark room, as is necessary with all other antitoxic serums.

The serum is useless for therapeutic purposes unless it is able to prevent death in a rabbit when given intravenously in a dose of 1·5 c.c.

It was found that the antivenine, like the toxin of the venom, is mainly carried by the leucocytes and not by the serum; for if the effusion from the peritoneal cavity of a vaccinated rabbit in which peritonitis has been excited be centrifugalised, the leucocytes which are deposited are found to possess a high antitoxic power, while the plasma has but little.

If the antitoxic serum be heated above 68° C. it becomes coagulated and is useless.

The practical results of the late investigations may be thus briefly stated:—

(1) That the injection of a sufficient dose of antivenomous serum (10 to 20 c.c.) prevents the toxic action of a lethal dose of venom given *later*, as would occur frequently when a ligature was applied above the bitten part at once, the venom having been kept out of the general circulation until after the patient had been injected with the serum.

(2) That the injection of a sufficient dose of the serum prevents intoxication by a lethal dose of venom given subcutaneously *before*, provided too long an interval has not occurred, which would include those cases where a ligature was not employed, or had been imperfectly applied, so that the poison had gained access to the general circulation.

(3) That as the resistance of man to the toxic action of the venom is greater as compared with the smaller animals, a much smaller dose proportionally of the serum is necessary to counteract the toxin.

(4) That if the venom has been injected directly into a vein, the result is always fatal unless the serum be injected intravenously before or at the same time.

(5) That the serum should be at hand in all districts where snake bites are common, and that the inhabitants should be instructed in the advantage derived from its use; particularly as the amount of venom usually injected by the snake is little above the minimum lethal dose, an interval of one to three hours being in most cases allowable between the time of the bite and the injection of the serum.

(6) That when toxic symptoms are already present the serum should be at once injected *intravenously*.

(7) That none of the ordinary precautions should be omitted even when the serum is available.

The following two cases show the efficiency of the serum treatment:—

One reported by Keatinge and Ruffler was that of a girl in Egypt bitten in the forearm by a snake believed to be a cobra; she became unconscious almost at once, and when seen was cold and collapsed with imperceptible pulse. 20 c.c. of antivenine were injected under the skin of the abdomen, and three hours after 10 c.c. more; from that time she gradually recovered. The second case is recorded by Rennie. A boy aged eleven in India was bitten on the right foot by a krait. In three minutes 8 c.c. of serum was injected into the subcutaneous tissue of the abdomen, hypodermic injections of pot. permang. being used locally. The boy made a good recovery.

Poisonous Fish, Diseases and Injuries Attributable to them

The subject of poisoning by fish is one on which there is very little recent information of any reliable character. Many ill effects in different parts are frequently put down to the ingestion or even handling of them. It may be stated, however, with certainty that these are more common in tropical than in temperate regions, no doubt due to the much more rapid decomposition of the fish in the presence of heat and moisture, and perhaps to the fact that as all animal life is more abundant in warm climates, so the increased competition in the struggle for existence has caused many fish to have developed peculiar organs having protective and poisonous qualities. The noxious characters, as far as man is concerned, may be divided into—

(1) Toxic effects produced by the poison contained in the fish itself when fresh.

(2) Toxic effects produced by the ingestion of fish undergoing putrefaction, either before being swallowed, or under certain conditions after it has been a longer or shorter period in the intestinal canal.

(3) The introduction into the body of specific pathogenic micro-organisms through the agency of the fish.

(4) Cutaneous wounds produced by the special armament of certain fish.

(5) Diseases or growths produced by parasites of which the fish is the definite or temporary host. In the constant investigation of fish markets for zoological purposes, particularly in the Indo-tropical and Chinese regions, I have been much impressed by the large number of apparently dangerous-looking fish that are habitually sold, and the advanced stages of decomposition which some of them frequently present, yet they seem to be used for food by the poorer classes habitually.

There used to be an old rule in the Navy that scaled fish were wholesome, and that fish without scales were not. This, however, is certainly not altogether correct, as many with large scales, as *Sphyræna*, *Pagellus*, etc., are at times markedly poisonous; others without scales, as the fresh-water *Siluroids*, are esteemed as excellent food.

As a matter of fact, poisoning directly due

to the consumption of fish is very rare in the naval service, and also among well-to-do Europeans in tropical regions.

The toxic properties inherent in fish, as Dr. Günther pointed out, may depend on various conditions; some are only poisonous at certain stages of growth, others only at special seasons, as at the breeding time; again, others are apparently dangerous after they have been feeding on poisonous foods; thus most of those beautifully coloured fish belonging to the families *Squamipinnes* and *Labridæ*, which frequent coral reefs and browse on the polyps of the young growing madrepores, etc., are generally considered to be dangerous; nevertheless, if these be properly cleaned before cooking, most may be taken with impunity. French medical officers have pointed out that many fish at other times wholesome become poisonous in the breeding season, and every one knows that a spent trout or salmon is very liable to give rise to gastric disturbance if eaten.

The symptoms of poisoning due to fish fall into two distinct groups: (1) true gastro-enteritis with colic and high fever, probably due to a *bacterial infection*; (2) nerve symptoms, often commencing some time after the ingestion of the food, attended by constipation, and various forms of paralysis, etc., probably due to *intoxication from the alkaloid substances* produced during decomposition.

The following fish are credited with producing poisonous symptoms when taken fresh:—

(1) *Pagellus erythrinus*, a "sea bream" common in Indo-Pacific waters, quoted as nearly causing the death of Quiros, the Spanish navigator, and also described as poisonous in Cook's *Voyages*.

Lethrinus mambo in the South Pacific is said to be poisonous when full grown, but harmless when young.

Many of the *Squamipinnes* or Coral fish, as before stated, acquire poisonous properties from their food. These fish are generally gorgeously coloured, and are like butterflies in the aqueous gardens which they frequent.

Sphyræna, or "Barracudas." Their flesh is as a rule eaten with impunity, but two species in the West Indies are known to occasionally produce intense symptoms of poisoning—gastro-intestinal irritation with pain, vomiting, and diarrhœa, etc., followed by marked prostration, and, in a few cases, death from syncope. If the fish be unwholesome, Poe states that the teeth become blackened at the base, and natives say that if a silver coin placed on the flesh becomes black, the fish is unfit for food.

Some of the mackerels frequently cause gastric irritation; several species of *Thynnus* or tunny are stated by Günther to be poisonous at times—being red-blooded fish, they are liable to rapid decomposition. The *Carangidæ*, horse mackerel or yellow-tails, have a very bad name at the Cape of Good Hope as being poisonous, especially when they are old, *C. falax* being the most dreaded. Almost every variety of this genus may be seen in the market at Aden for sale. After eating poisonous *Bonito*, *Tunny*, and *Horse Mackerel*, the symptoms are those of mild gastric enteritis, with urticaria, giddiness, headache, vomiting, and diarrhœa, which may assume a choleraic form, ending in collapse and death.

Fish of the herring family are undoubtedly very frequently extremely poisonous. Günther gives the following list:—

Clupea thryssa, the sardine doré of the West Indies, often causes a rapidly fatal issue. There is a saying that "if you begin at the head you never finish the tail." The symptoms are pain, prostration, convulsions, and unconsciousness followed by death, sometimes in a quarter of an hour, but generally in from two to three hours.

C. longiceps, *C. perforata*, *C. venenosa*, the three latter from the Indian Ocean, are all known to have caused intense purging and collapse.

C. humeralis of the West Indies is stated by Day to have caused death in a few minutes.

The marine "cat fish" or *Siluroids* are, as a rule, too loathsome to ever be much used for food. They are invariably rejected, if caught, on board ship, but are, however, constantly seen for sale in the native markets. Most of the species of *Balistes* (file fish), *Tetrodon* (globe fish), and *Diodon* (porcupine fish) are rejected as being poisonous; they are foul feeders, or live on coral and other zoophites. Two cases are recorded by Sir John Richardson of acute poisoning from eating portions of the liver of a Tetrodon. One man ten minutes after eating it became very ill, with flushed face, swollen lips, signs of intense gastro-intestinal poisoning, followed by paralysis, laboured breathing, cyanosis, and death in seventeen minutes. The second man died in twenty minutes. The whole fish was not more than eight inches long. Many of the small kinds are constantly seen for sale in the Bombay market and elsewhere, those from brackish and fresh water being more wholesome than the marine varieties. Macoy states that in Australia nearly all cases of fish poisoning are due to eating *Arripis truttaceous*, one of the sea perch. This may be sometimes due to decomposition, but fresh fish also produce unpleasant results in some people, the symptoms being flushing of the skin, particularly of the face, headache, vomiting, and a transient eruption, generally followed by rapid recovery, but a few deaths have been noted.

Muræna punctata, one of the "sea eels," is stated by Russell to be poisonous if eaten. Mosso states that the fresh blood of eels possesses highly poisonous properties, due to the presence of ichthyotoxin, like the toxalbumens of vipers.

Mussels or other shell-fish, though quite fresh, will sometimes produce severe symptoms, nausea, vomiting, diarrhœa, syncope, numbness of the limbs, and eruptions on the skin, with occasionally swelling of the tongue and mucous membrane of the throat. Those taken from the open sea are generally quite wholesome, the poisonous properties being derived from the foul water from which they have been gathered.

(2) *Putrefaction of Fish.*—This is the most common cause producing poisonous symptoms.

It is generally due to the action of micro-organisms breaking up the proteid substances present into a number of chemical bodies, some of which are harmless, others being very toxic.

The proteids are first split up into albumenoses, and then finally into the animal alkaloids known as "Ptomains"; these latter were first studied in detail by Selmi, and since then by Breiger, Van Ermengen, Sidney Martin, and others.

From decomposing fish Breiger isolated the following substances: *Trimethylamine*, *Dimethylamine*, *Methylamine*, *Neuridine*, *Cadaverine*, and *Putrescine;* some, as cadaverine and putrescine, are but slightly toxic, others are extremely so, rapidly causing death.

All "Ptomain" poisons are characterised by the combination of marked nervous symptoms, with gastro-intestinal irritation, and a tendency to coma, in which the patient may die. There is also almost always a more or less prolonged period between the ingestion of the food and the onset of the symptoms, "the incubation period"; when this is present the cause of the poisoning, according to Van Ermengen, is due to the presence of a special organism, *Bacillus botulinus*, this condition being known as Botutism. David describes an interesting instance of poisoning by red herrings. There were five cases, all in one family. Gastric symptoms and obstinate constipation, commencing some days after taking the food, occurred in all, followed by local paralysis of parts, double vision, and diminished reflexes. In two the dysphagia was so complete that feeding by a tube had to be resorted to. The paraplegic symptoms lasted for months, but all finally recovered.

Breiger isolated an alkaloid named *Mytelotoxin*, which is not destroyed by cooking, from the liver of mussels taken from foul water; this produces acute symptoms like those of "curare" poisoning, affecting the motor nerves, being quite distinct from those toxins which induce the gastro-intestinal irritation symptoms.

The treatment of all cases of Ptomain poisoning is to clear the stomach and intestines of the irritating substances as soon as possible, to give stimulants with discretion to counteract the cardiac depression, and where there is profuse diarrhœa and much pain opiates will be required; for the subsequent paralysis, massage and nerve tonics. "Tinned fish" are very liable quickly to undergo putrefactive changes, especially in hot climates; if then eaten, they produce severe symptoms, diarrhœa, vomiting, and collapse in a few hours, which may last for days or prove fatal.

In tropical climates, where the intestine is so ready under slight provocation to increased secretion, congestion, or ulceration, one cannot be too careful in the scrutiny of all tinned fish to be used for food; it is from these that on board ship fish poisoning most commonly arises.

(3) *The conveyance of specific pathogenic micro-organisms to man*, by means of oysters, mussels, etc., unquestionably takes place, perhaps more often than is generally believed.

The spread of typhoid has been distinctly traced to infected shell-fish, and reported accordingly by many medical officers of health and others. It is not uncommon in certain well-known localities to find oyster-beds on the foreshore immediately below the outfall of a sewer, and I have had it *stated to me* by a "grower" that in these positions the oysters are fatter and better in quality than those from more open situations.

Bacteriological examinations have been made demonstrating the presence of *B. enteritidis* and *B. cole communis*, etc.

Legislative measures for removing this evil have been over and over again brought forward, but so far ineffectually, the interference with the oyster industry and restriction of the area for beds being strongly opposed by a certain section of interested persons.

(4) *Poison Wounds caused by Fish.*—Perhaps the most widely feared fish producing cutaneous injuries are the "Sting Rays," belonging to the order *Batoidea*. These have one or more sharp barbed spines attached to some portion of the dorsal surface of the tail; these may cause severe lacerations when incautiously handling the fish, or when stepping on them while half hidden in the sand. In the first case I personally came across, the pain was so intense that the strong, healthy man almost fainted. There is no poison apparatus connected with the spines, but they are like poison arrows, being coated with mucus from the surface of the fish, which has peculiar irritating properties. Another class of fish, the *Scorpœnidæ*, are profusely provided with sharp spines on the opercular plates, fins, etc., which inflict irregular punctured wounds. Among the very dangerous fish are *Synancea verrucosa* and *S. horrida*, found in the Red Sea and on the coasts of Africa and India; in these species the dorsal spines are grooved, having small poison-bags attached, the venom being injected into the wound by pressure. Injuries from this fish occasionally cause death (Day). The symptoms vary according to the amount of venom injected; they are local pain, increasing and spreading from the wound, with swelling of the

part, lymphangitis and gangrene, attended with convulsions, delirium, and attacks of syncope.

Other very dangerous fish are the *Thalassophryna*, of which two species are known, one in the Pacific, the second in the Atlantic Ocean. These fish, according to Günther, possess as perfect poison sacs and tubular spines as any venomous snake. The poison sacs are attached to the bases of the opercular and dorsal spines.

In the "Weavers" *Trachinus*, common in European waters, the dorsal and opercular spines have deep double grooves, these being filled with fluid mucus, but there is no true poison apparatus. Wounds inflicted by them are followed by violent inflammation of the injured part.

Many genera of the "cat fish" tribe *Siluridæ* are excessively dangerous to handle, the dorsal and pectoral fins having very hard serrated bony spines, which may inflict serious wounds; in some of these fish glandular organs are found at the axils of the spines; the body is covered by an offensive tenacious mucus, which can readily inflict the wound. Great numbers are commonly eaten by the lower "castes" in India, they are therefore frequently caught; the fishermen immediately cut off the offending spines, it being rare to see a perfect specimen in the market.

Treatment of Wounds. — These should be enlarged and the blood allowed to flow freely, or the part may be ligatured above, and the poison removed by cupping or sucking the wound, then ammonia or spirits of turpentine may be applied, followed by fomentations, opium being given and stimulants as necessary. The wounds caused by the serrated spines of rays and cat fish almost always suppurate.

(5) *Fish may act as Intermediate or Definite Hosts.*—An example of the former is found in *Lota vulgaris*, which is commonly known to harbour the larval form of *Bothriocephalus latus* (*see* Cestodes). Congers are said to be infested with hydatids. A curious case has been described by Dr. Batten, namely, the fixation of a species of *Lepcophtheirus*, one of the "Calegidæ" or fish lice, on to the cornea of a fishmonger (which specimen he kindly sent to me). These semi-parasitic copepods are very numerous on many flat-fish, moving about actively on the skin some time after the death of the fish. The saline condition of the ocular conjunctiva, with a certain quantity of mucous secretion, render this position particularly suitable for these parasites if accidentally introduced. It is, however, very rare: I have never heard of or seen a second case. The parasite was successfully removed, vision not being impaired.

Snake-bite in the British Isles.

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As far as the British Isles are concerned, the subject of snake-bite is generally ignored in medical text-books, or at most is dismissed with a passing mention. The reason is, of course, that such cases are somewhat rare, though not more so than some other diseases and accidents that could be named, and also because the cases that do occur are rarely seen by those who write text-books, and indeed generally go unrecorded even in the medical journals. It is the country practitioner in remote districts, who has probably many miles to travel to see his patients, who now and then encounters a case, and who has very little time left him for writing up his observations to current medical literature. It is therefore the more necessary when a series of cases have come under the notice of a single individual—as has happened in the last year or two to the present writer—that these should be compared and recorded.

(*a*) *Species of Serpent involved.*—There are only three serpents found indigenous in the British Isles, and of these three one only is venomous. This is the adder or viper (*Vipera berus*). Like the other snakes, the adder is absent from Ireland, the Isle of Man, Guernsey, and Sark, but is present in greatly varying numbers in every county of England, Scotland, and Wales. It is the only snake found in Scotland, except in Roxburgh and Berwick, where very occasionally the ring snake or grass snake (*Tropidonotus natrix*) is met with. Its numbers vary with the nature of the district, as it retires before the progress of civilisation to the large woods, commons, heaths, and mountain fastnesses. The adder may be diagnosed from other species at once by the dark brawn or black zig-zag mark which extends along the whole length of the back, and by a V-shaped marking at the posterior end of the head. The adult length is from 18 to 25 inches as a rule.

(*b*) *Causes of Adder-bite.*—The accident occurs in nine cases out of ten from the person bitten being unaware of the proximity of the reptile. The natural instinct of the adder is to escape observation if possible. It is only when absolutely cornered that it makes a deliberate attack—for example, when in a cage or box, or in some other position from which there is no escape. The most common ways of sustaining this injury are by stepping on or near the adder, when it strikes just above the ankle; by picking up a stick or other object on the ground, not observing the adder lying at that spot; or by sitting down on a warm bank on which the adder is basking. In all these cases the adder strikes in self-defence. The anatomy of the fang and venom gland is similar to that of other viperine serpents, and need not be described here.

(*c*) *Diagnosis.*—As a rule the history is too definite to permit of any doubt, but in doubtful

cases, where the patient was alone and found unconscious, the presence or absence of the fang punctures must decide the point. The appearance of these marks is that of severe pin-pricks. In a case where the patient has been struck by an average-sized adder the two points of puncture will be from three-fifths to half an inch apart. But one fang only may have been used, or the adder may have struck twice, in which case the fang punctures will show a corresponding arrangement.

(*d*) *Symptoms.*—It is generally stated that the symptoms depend on the condition of the patient's general health at the time of the accident, and on the heat of the day or the season. The former applies to every accident that could be named, and has no particular relation to adder-bite. The latter has, in all probability, very little to do with the result. *The symptoms which follow an adder-bite depend on the dose of venom injected at the time.* Of course a strong man will survive a dose that might prove fatal to a weakly child, just as he would a dose of opium or any other poison. "The symptoms, which come on very rapidly, are, pain at the seat of the wound, sickness, and a feeling of extreme prostration, terminating in actual fainting and loss of consciousness. In fatal cases death occurs soon from heart failure. If, however, the dose injected was not so large, or the venom of the particular adder less potent, the patient recovers consciousness (or may not actually faint), and a set of secondary symptoms sets in. The day after the bite the vessels of the arm or leg, as the case may be, become painful, and the lymphatics stand out as dark lines. The limb becomes swollen, and the swelling may extend to the body. The patient, in fact, exhibits all the signs of severe local blood-poisoning in addition to great weakness of the heart. In some cases the limb shows considerable discoloration of a more or less green colour."[1] Should the case run a favourable course all these symptoms subside gradually, but it is usually six or eight weeks before the limb recovers perfect mobility and the patient feels well. The nervous symptoms exhibit considerable variation in different cases. Thus there may be little or no mental disturbance, or the patient may exhibit great terror or delirium. There may or may not be marked photophobia. The pupils may be dilated. Occasionally there is slight erythropsia.

The following is the most recent fatal case that has occurred in this country, reported to me by Dr. Eden Cass, under whose care the case came :—

History.—On June 8, 1901, J. Hartley, a little boy aged 4 years and 8 months, was chasing butterflies in a meadow by the side of a small stream. Walking through a patch of bog myrtle and heather, he said, "a little frog jumped up and bit him on the right leg." This was between 11 and 12 A.M. He ran home all the way, and when he arrived his face was a picture of terror. On hearing the child's story his father concluded he must have been bitten by an adder, and upon removing his stocking two small punctures were seen about the junction of the middle and lower third of the right leg. It was nearly 5 P.M. when the doctor arrived, he living some ten miles from the place of the accident. He found the lad curled up on two chairs, his face hidden under his arms, and away from the light. He was in great terror.

Symptoms.—The patient was dull, had been violently sick 10 or 12 times soon after reaching the house, and the bowels had moved once. His temperature was normal, pulse slightly quickened, heart sounds normal, did not complain of any pain, was very thirsty, and the pupils were normal. On examining the leg there was a small round blue mark about the size of a shilling, with a well-marked puncture. The second puncture was obliterated by some tar that had been applied. The leg as far as the knee was swollen to twice its natural size, was boggy to the touch, and of a dull white colour with a dark bluish tint under the skin in places. It was very hot, but not tender. Next morning, after a restless night, the boy was half comatose. He had been severely purged, and had passed both motions and urine in bed. He was still very thirsty, temperature normal, pulse 110. He could be roused by shouting at him The swelling had extended up the limb as far as the groin, the thigh being the same colour as the leg. Bright red and blue lines were well marked at the base of the toes on the dorsal aspect. The pupils did not react well; corneal reflex present. Next day (June 10), after another restless night, he was quieter, though occasionally throwing his arms about. He lay with his legs and hips bent, head flexed slightly on his back, with mouth open. The breathing was rather quick, temperature normal, pulse very rapid, and heart sounds very feeble. The eyes were fixed, pupils slightly dilated, no reaction, corneal reflex slightly marked. He refused nourishment, and was distinctly moribund. The condition of the limb was improved, no heat, swelling decreased considerably. The boy died at 2 A.M. that night.

Treatment.—Potassium permanganate was injected into the leg; liq. strych. given hypodermically; brandy, ammon. carb., and digitalis internally.

The disadvantages in this case were the great distance from medical aid, allowing time for the full absorption of venom into the system, and, secondly, the youthful age of the patient. Three adders were seen at the spot where the accident occurred a day or two afterwards when the uncle went to see it. The patient was a healthy, sturdy little fellow.

[1] *British Serpents* (Wm. Blackwood & Sons), p. 129.

Sneezing. *See* Hysteria (*Disorders of Respiratory Organs, Sneezing*); Nose, Nasal Neuroses (*Neuroses of Common Sensation, Paroxysmal Sneezing*); Physiology, Respiration (*Special Respiratory Movements, Sneezing*).

Snellen's Types. *See* Eye, Clinical Examination of (*Visual Acuity*).

Snoring. *See* Nose, Post-nasal Adenoids (*Symptoms, Snoring*).

Snow-Blindness. — The symptoms (photophobia, conjunctivitis) resulting from looking for long at the snow in bright sunlight.

Snuffles. *See* Syphilis (*In Children, Snuffles*).

Snuffs.—Insufflations or snuffs are medicinal substances in the form of light powders which can be drawn or blown into the nose, larynx, etc.; *e.g.* Ferrier's snuff in hay fever. *See* Hay Fever (*Treatment*).

Soap. *See* Sapo. *See also* Acne (*Treatment, Local*); Aseptic Treatment of Wounds (*Disinfection of Hands and of Skin*); Urine, Pathological Changes in (*Sediments, Unorganised, Soaps*).

Socaloin or Socoaloin. *See* Aloes and Aloin.

Socia Parotidis.—A separate part or lobule of the parotid gland; glandula parotis accessoria. *See* Mouth, Diseases of (*Diseases of the Cheeks*); Parotid Gland, Disorders of (*Inflammatory Conditions*).

Socordia or Secordia. — Without understanding (Lat. *se*, without, *cor*, heart or mind); silliness, or weak-mindedness; hallucination.

Soda. *See* Sodium.

Soden. *See* Balneology (*Germany, Muriated Waters*).

Sodium. *See also* Diet (*Mineral Constituents of Food*); Œsophagus (*Inflammation, Causes*); Toxicology (*The Alkalies*).—Symbol, Na. Atomic weight, 22·88. A soft white metal decomposing water. From it is prepared Liquor Sodii Ethylatis by disolving 22 grs. of sodium in an ounce of absolute alcohol. This is a syrupy fluid of a light brown colour, and is an excellent caustic for warts and other growths. The *salts of sodium* have a tendency to effloresce, as contrasted with the potassium salts, which are usually deliquescent. Therapeutically the sodium compounds are as a rule less depressant than the corresponding potassium salts, and are therefore preferred under certain conditions. Sodii Chloridum, common salt, is soluble 1 in $2\frac{3}{4}$ of water. Its official *dose* is 10-240 grs. Although in common use, it is probably not necessary for those living on an ordinary mixed diet; but it is essential as an addition to the food of vegetarians. Recently the œdema of Bright's disease has been treated by the employment of a "chlorine-free" diet. Large doses of salt are emetic. Rectal injections are used in the treatment of thread-worms. Normal saline solution—a ·8 per cent solution of sodium chloride in sterilised distilled water—is used for intravenous transfusion and for rectal and subcutaneous infusions. It is also largely used during the performance of surgical operations, in preference to antiseptic solutions. A solution of sodium chloride forms an excellent gargle in inflamed conditions of the throat. Sodii Carbonas is washing soda. It is soluble 1 in 2 of cold water. *Dose*—5-30 grs. Sodii Carbonas Exsiccatus is used in making Pilula Ferri. *Dose*—3-10 grs. Sodii Bicarbonas is known as baking soda. It is soluble 1 in 11 of cold water. *Dose*—5-30 grs. *Preparation*—Trochiscus Sodii Bicarbonatis, 3 grs. in each. The carbonate and bicarbonate of soda are more slowly absorbed than the corresponding potassium salts, and are less depressant. Solutions of sodium bicarbonate are employed as sedative lotions to relieve itching. The bicarbonate is largely used in the treatment of dyspepsia, especially in combination with bismuth and rhubarb. It is a stomach sedative, and helps to liquefy tenacious mucus. If given before meals it stimulates the secretion of hydrochloric acid, and if given some time after meals it neutralises the hydrochloric acid already secreted. Sodii Sulphas is known as Glauber's salts. Soluble 3 in 1 of water. *Dose*—30-120 grs. (repeated); $\frac{1}{4}$-$\frac{1}{2}$ $\overline{3}$ (single administration). The *effervescing sulphate* is given in similar doses. Soda Tartarata, the tartrate of sodium and potassium, known as Rochelle salt. Soluble 1 in 2 of water. *Dose*—30-60 grs. (diuretic); $\frac{1}{4}$-$\frac{1}{2}$ $\overline{3}$ (purgative). *Pulvis Sodæ Tartaratæ Effervescens* is Seidlitz powder. The blue paper contains 120 grs. of tartarated soda and 40 grs. of bicarbonate of soda. The white paper contains 38 grs. of tartaric acid. Sodii Citro-Tartras Effervescens is in the form of white deliquescent granules. *Dose*—60-120 grs. These sodium salts are excellent purgatives for occasional administration, especially in constipation associated with gout and in "bilious" conditions. They should be taken in concentrated solution first thing in the morning. They are frequently employed to accelerate and complete the action of mercurial purges. The sulphate is an important constituent of most of the natural aperient waters. The phosphate is a very mild and pleasant aperient. It has been used empirically in the treatment of exophthalmic goitre. Sodii Sulphis is prepared from sodium carbonate and sulphurous acid. Soluble 3 in 4 of water. *Dose* — 5-20 grs. It has

been recommended as an antiseptic in various diseases of the alimentary canal, and to prevent fermentation in gastric dilatation. It is now little used. The other salts of sodium—*iodide*, *bromide*, *salicylate*, etc.—are described under the different headings.

Soft Palate. *See* PALATE (*Injuries*, *Diseases*).

Soft Passages.—The name given to the ligamentous, muscular, and fascial parts lining the pelvis, through which the infant has to pass in the process of labour; they are contrasted with the hard passages, viz. the pelvis.

Soft Soap. *See* SAPO (*Sapo Mollis*).

Soft Sore. *See* SYPHILIS (*Primary, Hard and Soft Sore*); VENEREAL DISEASE (*Soft Sores or Chancroids*).

Softening. *See* BRAIN, ATROPHY, ETC. (*Chronic Progressive Softening*).

Soil. *See* CHOLERA, EPIDEMIC (*Etiology, Breeding Places, Soils*); CLIMATE (*Effect of Cultivation of the Soil*); METEOROLOGY (*Influence of Meteorological Conditions on Health, "Change of Soil"*); SEWAGE AND DRAINAGE (*Soil Pipes*).

Soja or Soya Beans.—The seeds of *Glycine soja* or *Soya hispida*, an East Indies plant, which are used in the dietetic treatment of diabetes mellitus.

Solanine. *See* SOLANUM.

Solanism.—Poisoning resulting from the eating of the berries of the Nightshade (*Solanum Dulcamara*) or, occasionally, from ordinary potatoes (*Solanum tuberosum*). *See* TOXICOLOGY (*Vegetable Foods, Potato*).

Solanum Dulcamara.—The Bittersweet or Woody Nightshade; it contains an alkaloid (*solanine*) which, by the action of dilute acids, is converted into a *sugar* and *solanidine*; *solanine* occurs also in small quantities in the potato (*Solanum tuberosum*).

Solar Plexus. *See* ABDOMEN, INJURIES OF (*Shock*); ADRENAL GLANDS, ADDISON'S DISEASE (*Morbid Anatomy, Condition of Sympathetic Ganglia*); ALCOHOLISM (*Visceral Variations*); PHYSIOLOGY, NEURO-MUSCULAR MECHANISM (*Spinal Nerves, Splanchnic Fibres*).

Solayres' Obliquity.—In normal labour the fact that the fœtal head lies with its long (antero-posterior) diameter in one or other of the two oblique diameters of the pelvic brim (and not in either the transverse or conjugate diameter) is known as Solayres' obliquity.

Soldier's Heart. *See* HEART, MYOCARDIUM AND ENDOCARDIUM (*General Pathology, Etiology, Excessive Physical Effort*).

Soleus.—A muscle of the calf, arising from the fibula and tibia and inserted into the tendo Achillis. *See* MUSCLES, TRAUMATIC AFFECTIONS OF (*Rupture*).

Solitary Glands or Follicles. *See* PHYSIOLOGY, FOOD AND DIGESTION (*Structure of Alimentary Canal, Small Intestine, Lymphoid Tissue*).

"Solurol."—A nuclein derivative said to act as a solvent of uric acid.

Solution.—A liquid containing a substance (medicinal, chemical) dissolved therein; in Pharmacy, this is known as a liquor, *e.g.* Fowler's Solution, Donovan's Solution, Normal Saline Solution, etc.

Somato-.—In compound words *somato-* (Gr. σῶμα, body) means relating to the body; e.g. *somatopleure* (the body-wall), *somatopagus* (twins united by the bodies, pelves and thoraces), etc. *See* FŒTUS AND OVUM, DEVELOPMENT OF (*Segmentation, Somatopleure*).

Somatochrome. *See* INSANITY, PATHOLOGY OF (*Pathological Anatomy, Cortical Nerve-Cells*).

Somatose.—A proprietary food-product, obtainable in the form of milk-somatose, iron-somatose, etc.

Somite.—A segment of the body of an embryo, or, more particularly, a protovertebra.

Sömmerfeld's Streptococcus.—A streptococcus found by Baginsky and Sömmerfeld in the tissues in cases of scarlet fever; it is not, however, regarded now as the causal organism.

Somnal.—A preparation consisting of chloral hydrate and urethane, given in doses of 30 grains for its hypnotic and diuretic effects.

Somnambulism. *See* HYPNOTISM (*Hypnotic State, Stages*); HYSTERIA (*Vigilambulism and Somnambulism*); MEMORY IN HEALTH AND DISEASE (*Periodic Complete Loss of Memory*); RHEUMATISM IN CHILDREN (*Nervous Affections*); SLEEP, NORMAL AND MORBID (*Somnambulism*); UNCONSCIOUSNESS (*Double Consciousness*).

Somnifacient.—Sleep-producing; hypnotic. *See* HYPNOTICS; PHARMACOLOGY (*Opium Series*); SULPHONAL; etc.

Somniloquence.—Talking during sleep. *See* RHEUMATISM IN CHILDREN (*Nervous Affections*).

Somnoform.—An anæsthetic containing ethyl and methyl chloride and ethyl bromide. *See* ANÆSTHESIA (*Ethyl Chloride*).

Somnol.—A preparation producing hyp-

notic effects (dose, 2 to 4 dr.), and consisting of a "synthetic product of chloral-urethane with a polyatomic alcohol radicle."

Somnolence. *See* Sleep, Normal and Morbid (*Morbid Somnolence*).

Somnone.—A proprietary preparation believed to contain opium, lupulin, and lactucarium, and to produce hypnotic effects.

Soor. *See* Stomatitis (*Parasitic or Thrush*).

Soot-Cancer.—Chimney-sweep's cancer. *See* Tumours (*Carcinoma*).

Sophomania.—A monomania of wisdom; a form of megalomania; the patient boasts of possessing superior wisdom. *See* Insanity, Nature and Symptoms (*Monomania of Exaltation*).

Sopor.—The condition of deep sleep; lethargy or stupor (almost).

Soporific. *See* Hypnotics.

Sorby-Beck Microspectroscope.—An instrument which can be placed in the tube of the microscope in place of the ordinary ocular and used for the spectroscopic examination of the blood; the blood may be conveniently placed in what is called a Sorby tubular cell for this examination.

Sordes.—The crusts which form on the teeth in diseases (*e.g.* typhoid fever) accompanied by great exhaustion (Lat. *sordere*, to be foul).

Sore. *See* Delhi Boil; Furunculus Orientalis; Natal Sore; Benjdeh Sore; etc.

Sore Mouth. *See* Stomatitis.

Sore Nipples. *See* Puerperium, Pathology (*Affections of Breasts and Nipples*).

Sore Throat. *See* Diphtheria; Pharynx (*Acute and Chronic Pharyngitis*).

Sore, Veldt. *See* Skin Diseases of the Tropics (*Veldt or Natal Sores*).

Sores, Soft. *See* Venereal Disease (*Soft Sores or Chancroids*).

Sorrento. *See* Therapeutics, Health Resorts (*Italian*).

Sorrocco.—Sickness (resembling seasickness) occurring in South America (higher parts); also called *puna*.

Souffle.—A blowing sound heard on listening over the veins of the neck in anæmia, over the uterus in pregnancy and some cases of fibroid tumour (*uterine* or *placental* souffle), and over the spleen in malaria and leukæmia; the *funic* souffle is said to be the sound of the blood passing through the compressed umbilical cord of the fœtus, but its occurrence is doubtful. *See* Pregnancy, Diagnosis (*Uterine and Funic Souffle*).

Sound. *See* Physiology, Neuro-Muscular Mechanism (*Hearing, Qualities of Sound*); Physiology, Circulation (*Sounds of the Heart*).

Soup. *See* Diet (*Animal Foods, Soups*); Invalid Feeding (*Soup-making, Varieties of Soup*, etc.).

South Africa. *See* Therapeutics, Health Resorts (*South Africa*).

Southey's Tubes.—Small drainage tubes for carrying off the fluid from the subcutaneous tissues in cases of anasarca, etc. *See* Hydrocephalus (*Surgical Treatment*); Paracentesis.

Soxhlet's Steriliser.—An apparatus for sterilising milk for infant feeding; the bottles of milk stand in boiling water in a metal chamber with a water jacket. *See* Infant Feeding (*Sterilisation*).

Soy Biscuits. *See* Invalid Feeding (*Cookery in Diabetes, Soy Flour*).

Soya Beans.—The beans *Soya hispida* can be made into a flour which contains very little sugar or starch, and is on that account useful in the dietetic treatment of diabetes.

Sozoiodol.—An antiseptic powder, having the formula $C_6H_2I_2(SO_3H)OH$, and used commonly in the form of the sodium, potassium, or lead salt; iodoparaphenol sulphuric acid or di-iodoparaphenol sulphonic acid.

Spa. *See* Balneology (*Definition, Spa Treatment*); Gout (*Treatment, Spa*); Mineral Waters (*Chalybeate*).

Space.—A term used in descriptive and regional anatomy for more or less closed-in places inside or on the outside of the body; *e.g.* the *subarachnoid* space, the *rectovesical* space, and the *axillary* space.

Spain. *See* Balneology (*Spain and Portugal*).

Spanæmia or Spanemia.—Hydræmia (Gr. σπᾰνός, scarce).

Spanish Fly. *See* Cantharides.

Spanton's Operation.—A method of treating hernia radically, by passing a sort of corkscrew instrument through the canal.

Sparagmus.—A convulsive seizure (Gr. σπᾰραγμός, a rending); epilepsy.

Sparteina.—Sparteine ($C_{15}H_{26}N_2$) is a

poisonous alkaloid obtained from broom tops (*Scoparii Cacumina*); poisoning by sparteine is called *spartism*. *See* Alkaloids (*Vegetable*); Broom Tops.

Spasm.

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By muscular spasm is meant an unusually prolonged or recurrent, and often excessive, contraction produced irrespective of the will. Spasm may be either tonic or clonic, and may affect either voluntary or involuntary muscle.

Physiology. — Contractility is an inherent birthright of protoplasm, and therefore of muscle, and a muscular contraction produced by means of a nervous stimulus is but a sudden heightening of its normal tonus, or so-called physiological tone. This tonus, ever varying in degree, is largely dependent upon a constant succession of nervous impulses reaching the muscle from its trophic centre, nerve cells in the spinal cord or medulla, and is therefore dependent in turn on varying neural tonus, but not entirely so. Involuntary muscle may continue to contract rhythmically when severed from all nervous connections, as seen in the excised heart muscle of tortoise. Again, circulating poisons may affect muscular irritability directly, and not by way of the nervous system, as veratria, ergot, and digitalis, or in the rapid onset of rigor mortis after death from cholera, or in an animal hunted to death.

Cramp, or painful spasm, the irregular tetanic contractions pressing on intra-muscular nerve-endings, and thus producing pain, may be due to circulating toxins produced within the body, as is seen in the cramps met with in diabetes, tetany, and in uræmia. Cramps may be bacterial in origin, as from the toxines of tetanus or hydrophobia, or they may be due to poison absorbed from without—organic, as in ergotism, or metallic, as in lead-poisoning. Cramp, again, may result from fatigue, the irritable state of the muscle perhaps depending on local accumulation of metabolic products.

Anæmia of muscle, again, may so heighten its irritability as to produce spasm or cramp, as is seen in the nocturnal cramps in the legs that anæmic women are liable to. In this case the spasms are not relieved by extension of the limb; but getting out of bed, by the assuming of the erect posture, improves the blood-supply to the limbs, when the cramps will pass off. The same variety of painful spasm or cramp is seen in some cases of progressive arteriosclerosis, or endarteritis obliterans, the condition being named by Charcot "Claudication intermittente." I have seen precisely the same condition in the calf muscles after popliteal thrombosis of both legs, in which the exertion of walking a hundred yards always brought on painful cramp in the calves, though nothing was noticed while sitting or moving quietly about the house. This is explained by the increased contractions of the gastrocnemii in the effort of walking, demanding the physiological increase of blood-supply necessary for a muscle in action, yet denied to it by the insufficient collateral circulation developed after the popliteal thrombosis, thus producing a relative anæmia of the muscle. The same pathology explains the painful cramp of the heart muscle in angina pectoris, attacks being induced either by diminution in calibre of coronary branches from vasomotor spasm, or from progressive atheroma suddenly diminishing the blood-supply to certain territories of heart muscle, or by exertion or emotion calling for more frequent contractions without the corresponding dilatation of coronary vessels to supply the hard-worked muscle, the failure of dilatation being due to arteriosclerosis, or vasomotor spasm, or to a combination of these causes.

Congenital peculiarities of the muscle fibres may also result in transient spasm at the commencement of a movement, as in Thomsen's disease. I have also seen persistent tonic spasm with hypertrophy of both sterno-mastoids in a case of pseudohypertrophic muscular dystrophy producing double wryneck, or retraction of the occiput with protrusion of the chin.

Spasm is, however, largely reflex in origin in almost all cases, and the excessive stimuli reaching the muscles and causing them to contract depend in turn upon afferent impulses running centripetally from the muscles themselves, the skin, joints, mucous membranes, etc. That this is so may be shown by the flaccidity and apparent total paralysis produced in a limb by section of all the posterior roots that conduct afferent impressions from it to the spinal cord.

Muscle tonus, therefore, is in part dependent on the conditions affecting the muscular substance directly, but more so on the varying tonic stimuli reaching it from its spinal nerve

centre. These latter are again dependent on conditions directly affecting the nutrition of the nerve cell itself, toxic or otherwise, and to a large extent on stimuli reaching the nerve cell from other neurons, stimuli received from the peripheral skin, joints, etc., and especially from two important sources, the cerebral cortex and the cerebellum. Lesions may be irritative or paralytic, and it is to be expected, therefore, that diseases affecting either the muscles directly, or the peripheral nerves, the spinal centres, or the cerebral or cerebellar cortex, or their conducting paths to the lower medullary and spinal centres, should in certain cases produce excessive muscular tonus or spasm, and in others diminution of muscle tonus or flaccidity. As examples of simple reflex spasm from irritation of peripheral nerves may be quoted spasm of the adductors of the glottis due to a foreign body in the larynx, trismus from carious teeth, renal and biliary colic from calculus, and rigidity of the abdominal muscles in peritonitis, diaphragmatic pleurisy, appendicitis, etc. Stimulation of the peripheral nerves generally increases the muscle tonus in the corresponding segment, as is seen in the increased knee-jerk produced by rubbing the skin over the vastus internus, though, on the other hand, painful stimulation of the periphery may sometimes diminish tonus, as is seen in cases of persistent violent ankle clonus, which can be arrested by forcible painful flexion of the great toe. Impairment of the conducting power of the sensory nerves, by preventing afferent stimuli from reaching the spinal nerve centres, tends to abolish muscle tonus, as is seen by the loss of knee-jerk in peripheral neuritis and in tabes, which latter is often characterised by marked hypotonia. While afferent impulses reaching the spinal nerve centre from the periphery tend to heighten muscle tonus, those reaching it along the pyramidal tracts from the cerebral cortex are of a two-fold nature. Tonic impulses from the cortex appear to inhibit muscle tonus, as seen in the increased knee-jerk when the attention is distracted by gripping with the hand. Similarly, paralytic lesions of the hemisphere are followed by rigidity with increased deep reflexes, while irritation of the cortex as in meningitis may abolish the knee-jerk. On the other hand, intermittent explosions of nerve force in the Rolandic area so stimulate the lower spinal centres as to produce spasm and convulsion. While the cerebrum has thus a crossed control on muscle tonus of the opposite side of the body, the cerebellum, conversely, appears to exert an uncrossed effect, partly through Deiters' nucleus and the descending antero-lateral tract, and opposite in kind to that of the cerebral hemispheres. Thus, tonic impulses from the cerebellum appear to increase muscle tonus, causing rigidity, while intermittent explosive stimuli from the cerebellar cortex produce the opposite effect, viz. relaxation. As an illustration of this fact, we may quote the results obtained by Horsley and Löwenthal after removal of both cerebral hemispheres in the dog and cat, when active extension tonus of the limbs is obtained. Sherrington names this condition decerebrate rigidity, and states that the spasm is so great that a cat in this condition placed on its four feet will remain so for several days. Hemisection of the spinal cord, or of the bulb just above the pyramidal decussation, abolishes this rigidity on the same side, proving that this excessive tonus is the result of an uncrossed influence. Horsley and Löwenthal, moreover, found that when this decerebrate rigidity has been produced by removal of both cerebral hemispheres, faradic stimulation of the upper surface of the cerebral hemisphere caused immediate relaxation on the same side, the tonus being immediately re-established on shutting off the current. The uncrossed influence previously referred to is therefore almost certainly the tonic impulses proceeding from the cerebellar cortex, increasing muscle tonus and causing rigidity, while the intermittent explosive stimuli from the cerebellum cause relaxation, being the opposite effects to those due to the cerebral cortex. All forms of spasm are diminished during sleep.

Varieties of Spasm.—Spasm may be either tonic or clonic. Its varieties may be classified under five headings—(1) Organic, (2) Toxic, (3) Reflex, (4) Functional, (5) Hysterical.

1. Spasm, either tonic or clonic, may be produced by various organic lesions of the cerebral cortex and its pyramidal fibres, the medullary and spinal nuclei, and of the motor nerves, and the lesions may be either irritative or paralytic. When discussing the physiology of spasm we referred to the part probably played by the cerebellum in producing the late rigidity of hemiplegia, and of paralysis agitans, which may be looked on as a form of double hemiplegia, yet there is little clinical evidence to show the effect of irritative or paralytic lesions of the cerebellum in producing spasm. Irritative lesions of the cerebral motor cortex, causing intermittent explosive discharges of nerve force, such as a tumour or localised patch of softening, cause spasmodic muscular clonic contractions of the type familiar to us as Jacksonian convulsions. These may be limited to one limb, or the face on one side, or may become general. Paralytic lesions of the cortex or of the internal capsule are followed after a few weeks by a condition of spasm, most intense in the most paralysed part, known as late rigidity, which is permanent. The destructive lesion may be actual loss of substance from injury or operation, or the result of hæmorrhage, thrombosis, or embolism, or tumour, or of pressure from hydrocephalus. The late rigidity may be combined with recurring chronic convulsion, as in post-hemiplegic epilepsy, or in tumour in the Rolandic area.

The spasm of late rigidity is a tonic contraction affecting the flexors of the arm and hand mostly, and the extensors of the leg. This tonic muscular contracture eventually leads to actual contracture or muscular shortening. This is easily to be distinguished from the lead-pipe contraction of hysterical spasm, in which the spasm of the flexors of the fingers is just as marked when the wrist is flexed as when extended, while in hemiplegic late rigidity flexion of the wrist abolishes the rigidity of the fingers. When hemiplegia has been acquired early in life, the spasm of the hand is not infrequently associated with slow, irregular movements, known as mobile spasm, and the severer forms as athetosis. Most usually it affects the hand, sometimes the whole arm, and sometimes the foot. The movements are occasionally very severe, and are intensified by voluntary movement. The lesion, most commonly due to softening from vascular occlusion, may be cortical or capsular, or even basal. The most severe case I have met with was in a woman of 35, who had a severe fall at the age of three years, the movements being first noticed three or four years later. There was considerable right hemiplegia of arm and leg, with paralysis of the left third nerve, the lesion being apparently situated in the crus. In her case the movements ceased entirely during sleep, though it is said that they may continue in slight degree. Lesions of the nuclei in the pons, medulla, and cord may also give rise to both irritative and paralytic spasm, though less commonly than supranuclear lesions. In three cases I have seen trismus from spasm of the masseters and temporals so marked in cases of infiltrating gliomata of the pons and medulla, that the mouth could not be opened with any reasonable force, the spasm being no doubt due to irritation of the motor nuclei of the fifth nerve. Facial spasm is sometimes probably due to irritation of the nucleus, and spasmodic torticollis is no doubt sometimes due to overaction of basal nuclei. Laryngeal crises in tabes must also be due to explosive discharges in the vago-accessory nucleus, causing the adductor spasm.

Irritation of the motor nerves also may cause spasm. For example, tonic and clonic facial spasm may be caused by pressure of a cerebellar tumour on the nerve; in the condition known as ophthalmoplegic migraine, in which there are attacks of severe headache associated with recurrent paralysis of the third nerve on one side, after the paralysis of the levator palpebræ has become persistent between the attacks, yet during the attacks there may be clonic convulsion of the levator palpebræ, causing the eyelid to flash up and down. This phenomenon is no doubt due to irritation of the third nerve, as in reported cases there has been found to be pressure on the third nerve from exostoses or thickening of the membranes at the base. Instances of spasm from irritation of motor nerves are by no means common, though it is a frequent result of irritation of sensory nerves. Tonic spasm, and frequently clonic contractions also, is an invariable sequel of facial paralysis of moderate severity, causing the palpebral aperture to appear smaller on the paralysed side, and the naso-labial fold deeper. This first begins to appear after three months from the onset of the paralysis, and increases gradually during several months. In severe cases of facial paralysis in which the recovery of voluntary power has been only slight, the additional contracture produced by this means is of great cosmetic value in restoring the apparent symmetry of the face, and may be unhesitatingly allowed for in the prognosis, if the nerve lesion is not a complete one, care being taken to remember that in the severest cases, in which the paralysis is absolute and remains so, there is no resultant contracture either. According to Gowers, this late spasm is the result of changes set up in the nucleus secondary to the nerve lesion, whereby there is tonic overaction, the breaking down of normal lines of resistance between the different parts of the nucleus permitting the too easy spread of discharges of nerve energy, whereby there is overaction of all the muscles on the paralysed side seen in slight movements. These changes are easily discernible in the facial muscles, but it is much more difficult, if not impossible, to make out this change in the limb muscles. Contracture of the antagonists of the paralysed muscles in neuritis, poliomyelitis, and in all cases in which the attachments of a muscle are brought permanently nearer together, should not be considered as cases of spasm, inasmuch as the shortening is due to physiological changes in the shape of the muscle brought about by the permanent approximations of its attachments.

2. Instances of spasm due to the effect of toxins acting directly upon muscles have been given in ergot, veratrine, and digitalis. The poisonous element in ergot causing muscular contraction appears to be the sphacelinic acid and cornutine, which act on involuntary muscle, especially the muscular coats of the arteries, the uterus, and intestines. Veratrine and digitalis both act also directly upon the muscular substance of the heart, the period of contraction being very markedly lengthened by green hellebore. In chronic ergot poisoning muscular contractions and convulsions result from the action of the poison upon the spinal cord. Spasm of the legs with paralysis, or spastic paraplegia, also occurs in two other forms of grain poisoning — pellagra, produced by musty maize, and lathyrism, which is the result of disease affecting the chick pea, or *Lathyrus sativus*. Tetanus, tetany, and strychnine convulsions are instances of spasm produced through

the agency of poisons affecting the spinal centres and nerves.

3. Spasm frequently occurs reflexly through irritation of sensory nerves. Irritation of the fifth nerve from carious teeth or a dental abscess may cause severe trismus or sometimes facial spasm. Joint inflammation may similarly cause spasm of muscles, preventing the joint from being moved, as is seen in arthritis of the temporo-maxillary joint causing trismus. Painful spasm of the bile duct, ureter, and bladder are only too frequent results of irritation by calculus, as is also retention of urine from spasm of the sphincter vesicæ following operations about the rectum. Blepharospasm, or tonic contraction of the orbicularis palpebrarum, is associated with photophobia due to conjunctivitis, phlyctenular and other corneal ulcers. The afferent loop of the reflex arc in these cases is the fifth nerve, and the reflex spasm is not due directly to the light. Blepharospasm has indeed been recorded from corneal ulcers in a blind eye. Light falling on the retina rarely produces blepharospasm reflexly, though photophobia may be associated with optic atrophy, and unilateral blepharospasm be due to slight diplopia. Spasm of the ciliary muscle is not unfrequently met with in children, the subjects of hypermetropia. This form of spasm should perhaps be included in the next section amongst the group of occupation neuroses, or fatigue spasms.

4. Clonic blepharospasm or twitching of the orbicularis palpebrarum is an instance of functional spasm more frequent in neurotic subjects, started sometimes by mimicry, but very difficult to cure. It is sometimes called convulsive tic, and is allied to other habit spasms, such as clonic contraction of the zygomatici or frontales, wrinkling of the eyebrows, sudden jerking movements of an arm, or sniffing. A curious spasmodic cough, known as the barking cough of puberty or cynobex hebetis, is also a form of habit spasm. Clonic contractions of the diaphragm, producing hiccough or singultus, is also sometimes functional in origin, though it may at other times apparently be started by irritation of the visceral branches of the vagus nerve.

Paramyoclonus multiplex, or myoclonus, was originally described by Friedreich as clonic spasms in symmetrical muscles of all four limbs, ceasing during sleep and during voluntary movements. Further observation of cases has shown, however, that the spasms may affect the muscles of the trunk, and even of the face, in something less than half the number of cases. The ocular muscles always escape. Generally the muscles are affected symmetrically on the two sides of the body, sometimes only parts of muscles, the spasms being shock-like and not necessarily always synchronous or rhythmical. In severe cases, co-ordinated movements, such as walking, may be much interfered with, and in a certain proportion of cases epileptic fits also occur, the muscular spasms being generally worse immediately preceding the fits. Several members of the same family may be affected, males being much more frequently affected than females. There is generally complete absence of any trophic symptoms, and there is usually no alteration of sensation. The deep reflexes are generally increased. The disease is most likely to be confounded with chronic chorea, convulsive tic or habit spasm, and hysteria. From chorea, the symmetrical affection of the muscles in myoclonus, and the grouping of the affected muscles not resembling the pseudo-voluntary movements of chorea, should suffice to distinguish the disease. In Electric Chorea or Dubini's disease, the acuteness of the onset, with pyrexia, followed by muscular atrophy and loss of electrical reaction, should prevent its being confounded with paramyoclonus. Myoclonus runs a very chronic course, and though temporary cure may be met with, relapses are common. Death is usually due to intercurrent disease.

Nodding spasm, head nodding or spasmus nutans, is a condition met with in young infants, due to clonic contractions of the deep cervical muscles, producing salaaming or nodding movements of the head. It is generally found associated with nystagmus, often of one eye only, and the children are often rickety. It is not of any serious import.

In idiopathic epilepsy the stages of tonic and clonic convulsion in the fit are really instances of functional spasm—functional in the sense that no lesion has been found to account for them, though they no doubt depend on instability of nutrition in certain areas, causing periodic explosions of nervous energy, often started by reflex causes. For the same reason the rigidity of paralysis agitans may be looked on as functional spasm, inasmuch as no lesion has yet been discovered in the nervous system which can adequately account for the disease. This rigidity, affecting the muscles of the trunk, face, and limbs, and indeed almost all the muscles of the body, is perhaps the most characteristic feature of the disease, and has been supposed by Hughlings Jackson to depend on cerebellar influx into parts normally controlled by the cerebrum; the weakness being really due to a double hemiplegia of very gradual onset, often more marked on one side at first, due to some chronic nutritional change affecting the nerve cells of the motor cortex, too fine, perhaps, to admit of microscopical demonstration. Spasmodic torticollis is another example of functional spasm, sometimes purely tonic, though more often a combination of tonic and clonic spasm of the rotators of the head. Torticollis may be produced by very different causes, and care must be taken to distinguish

the spasmodic form from wryneck due to rheumatism of the neck muscles, cervical caries or enlarged glands, congenital shortening of the sterno-mastoid from birth injury, and hysterical torticollis. I have also known it occur in tabes, and to accompany the extensive paralysis following thrombosis of the basilar artery. In this latter case the torticollis was towards the left, as it generally is in the functional cases, while the paralysis of the arm and leg was most marked on the right side, with intense rigidity. During every effort of conversation there were marked clonic movements of the head towards the left shoulder. Other lesions at the base, such as tumour and meningitis, may also cause torticollis and retrocollic spasm. An important group of cases presenting functional spasm as a symptom are the occupation neuroses, or fatigue spasms, such as writer's cramp (*see* article on "Occupation Neuroses").

5. Hysterical spasm may affect a single group of muscles, or the whole trunk and limbs may be in a condition of intense rigidity, known as catalepsy. Hiccough may occur as a hysterical manifestation, and I have seen stiffness of the neck muscles, with the risus sardonicus, trismus, and tonic rigidity of the abdominal muscles, with some opisthotonos, an almost exact mimicry of tetanus, produced in hysteria. Hysterical spasm, though functional in the sense that no lesion can be found to account for the symptoms, differs from those forms spoken of above as functional in being more distinctly dependent on neurotic causes, in being more quickly established, and in being more easily and quickly cured by moral treatment and suggestion. There is a large variety of cases which can be conveniently classed as hysterical, and which it is certainly advantageous to separate from those included above under the term functional. There can be no objection to the term "hysteria" so long as its Greek derivation is not included in the pathology of the disease and it is remembered that its manifestations occur in men as well as in women. The following case is a typical example of hysterical spasm. A young man, æt. 23, was doing some carpentry work on a building. About four o'clock in the afternoon he cut his left hand on the palm near the wrist with a piece of broken glass. It bled a good deal, and he stated afterwards that he was rather nervous about it, though he did not cease work, and went home at six o'clock as usual. While having supper at eight o'clock he noticed that the little finger of his left hand was becoming flexed into the palm; this was soon followed by similar flexion of the ring finger, and later on in the evening by the remaining fingers. By one o'clock in the morning he was so alarmed at the condition of his hand that he came to St. Mary's Hospital, where it was found that all the fingers of his left hand were tightly clenched into the palm, the thumb outside the index finger, and that there was considerable anæsthesia of the whole hand. Next morning when I saw him his hand was in the same condition of rigid spasm of the fingers, and there was complete anæsthesia to all forms of sensation over the whole hand as high as the wrist, ending sharply at the level of the joint. The spasm resisted all attempts to unclench the fingers, but strong faradism applied to the hand dissipated all the spasm and anæsthesia in less than two minutes. Other cases of hysterical spasm which have either been allowed to persist untreated or have resisted treatment may remain in tonic contracture for years, until organic shortening of the muscles from permanent approximation of their attachments takes place

Diagnosis. — If the cause of the muscular spasm is not obvious, reflex causes of irritation of peripheral nerves should always be carefully sought for, the joints in the neighbourhood of the affected muscles examined, and any possibility of a toxic origin inquired into. The chief difficulty usually lies in distinguishing functional and hysterical spasm from that due to organic disease of the nervous system. The presence of muscular atrophy or of any increase or loss of the deep reflexes on one side, which cannot be sufficiently otherwise accounted for, will be of the greatest value in diagnosing an organic lesion. The peculiar spasm of the legs in spastic paraplegia can be distinguished from hysterical paralysis by the fact that in the latter when traction is made upon one limb the other does not follow it, whereas this occurs in spastic paraplegia of organic origin owing to the fixation of the lower extremities to the pelvis by tonic muscular contraction. An extensor plantar reflex, true ankle clonus, incontinence of the sphincters, girdle pain, optic atrophy, and nystagmus will all be of assistance in diagnosing a spinal or cerebro-spinal lesion. In hysterical paralysis of the legs the plantar reflex is often absent, and in many cases the curious irregular distribution of the spasm, paralysis, and anæsthesia present, which it would be impossible to account for by any organic lesion, will often give the clue to a correct diagnosis of hysteria. It should never be forgotten, however, that organic disease may be present in addition to hysterical symptoms, and the presence of the latter may have been evoked by the real disease, which thus may be overlooked.

Treatment. — Hysterical spasm should be treated generally upon the same lines as other hysterical manifestations, by isolation from depressing surroundings or too sympathising relatives, by massage, douching, and by faradism. The aim of the treatment is so to react on the higher centres as to enable the volitional power of the patient to regain its proper sway. For this reason faradic treatment will

have more chance of success in dissipating hysterical paralysis if the patient has had no previous experience of the battery, and if the treatment is applied fairly sharply, after he or she has been reassured as to the good effects the treatment will have. For this reason, in hospital I prefer to treat a case of hysterical paralysis in the electrical room, where the patient is confronted with strange surroundings and a large battery, than to take a smaller battery up to the ward, where the surroundings are more familiar and the atmosphere generally more sympathetic. In such cases it is the moral effect of the severe treatment in stimulating the sensorium which effects a cure, not the actual electricity.

Organic spasm should be treated by massage and by sedatives, as bromide. Occasionally opium is of service, though care must be taken in its use. The constant current applied to the part is sometimes of great benefit, and should be given with the anode over the seat of spasm, and a large plate for kathode on the spine. This treatment, with the addition of small doses of opium, may sometimes considerably reduce the spasm in spasmodic torticollis. The rigidity of the arm and leg following hemiplegia is usually considerably benefited by the sinusoidal current together with massage. This is very easily applied where the alternating current is used for electric lighting, by using a simple transformer or volt-regulator, and connecting it up to two electrodes placed in a foot-bath and arm-bath respectively, in which the patient places his paralysed foot and forearm for twenty minutes daily. Facial spasm following neuritis is most persistent, and is best treated by gentle massage. Electricity perhaps does more harm than good in these cases after spasm has become established. Habit spasm of the face or convulsive tic should be treated by the administration of arsenic and iron, with occasional sedatives administered beforehand if the patient has to expose himself to any excitement. In children habit spasm can often be cured by change of scene and general surroundings, and the promise of reward for each day passed without any spasms is likely to do good by its constant restraining effect on the cerebrum. Punishment is worse than useless. It should also be borne in mind that habit spasm in the young is occasionally the result of self-abuse, and requires appropriate treatment.

Spasmus Nutans. *See* Head-Shaking; Spasm (*Nodding Spasm*).

Spastic.—Relating to or produced by spasm; of the nature of spasm, *e.g. spastic paraplegia. See* Brain, Cysts of the (*Porencephaly*); Deformities (*Arising from Infantile Hemiplegia and Spastic Paralysis*); Paralysis (*Spastic Paralysis, Varieties*); Toxicology (*Vegetable Foods, Spasmodic Ergotism*).

Spasticity. *See* Spasm (*Physiology of Cramp*).

Spatula.—A flat blade of metal or wood used to depress the tongue in examinations of the pharynx, or (in Pharmacy) to mix ointments (Gr. σπάθη, a broad blade).

Spaying.—Removal of the ovaries; oophorectomy (Gr. σπάω, I draw out or pluck off). *See* Ovaries, Diseases of (*Removal*).

Speaker's Cramp. *See* Neuroses, Occupation (*Etiology*).

Specialism.—The devotion of a medical man to one special branch of medical or surgical practice, *e.g.* dermatology, ophthalmology, gynecology, or insanity; the branch so practised is termed his *speciality*, and he is termed a *specialist* (a skin specialist, an eye specialist, etc.).

Specific.—Anything which is distinctly defined or determined is called specific, *e.g. specific immunity* (*see* Immunity) or *specific gravity* (*see* Blood, *Estimation of Specific Gravity*); also, a medicine which has a definite and well-marked curative effect in a particular disease (*e.g.* quinine in malaria); also, in a restricted sense, syphilitic (*see* Syphilis).

Spectacles. *See* Refraction.

Spectra. *See* Spectroscope in Medicine. *See also* Blood (*Spectroscopic Examination*); Colour Vision; Hæmaturia (*Spectroscopic Examination*); Hæmatoporphyrinuria; Hæmoglobinuria; Pigments of the Body and Excreta.

Spectroscope in Medicine.

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See also Blood (*Spectroscopic Examination*); Colour Vision (*Spectra*); Hæmaturia; Hæmatoporphyrinuria; Hæmoglobinuria; Physiology, Blood (*Spectrum Analysis*); Pigments of the Body and Excreta.

Preliminary Physical Considerations. — Viewed from the physical standpoint light consists of waves in a medium called the ether which fills space. In the waves of light the motion of the particles is transverse to the direction of propagation of the disturbance.

During the interval of time necessary for a complete vibration, the wave motion propagates itself through a distance known as the wave length (λ). The velocity of light is the distance traversed by the wave motion in one second, and in a vacuum is constant for light of all wave lengths. It is measured by the ratio of the wave length to the period of vibration. The wave length determines the quality or colour of the light. It is longest for red light, and successively shorter for orange, yellow, green, blue, indigo, and violet light. From these facts it also follows that the period of red light is longer than that of violet, the intermediate colours having intermediate times of vibration. The velocity of light in its passage through a glass prism is less than *in vacuo*, and also depends upon its wave length. The shorter the wave length of the light transmitted the greater is its retardation. In consequence, light of shorter wave length is refracted to a greater degree than that of longer wave length. Mixed light containing light of different wave lengths may therefore be decomposed into its constituents by means of a glass prism. The process of decomposition is known as dispersion, and the coloured band resulting from the decomposition of mixed light by a glass prism is termed a spectrum. The instrument used for the analysis and examination of light is known as a spectroscope. Rays of homogeneous light, *i.e.* light containing a series of waves of one wave length, undergo deviation on passing through a prism, but are otherwise left unaltered. When the entering and emergent rays of homogeneous light are symmetrically placed with reference to the refracting surfaces of the prism, the deviation is minimal.

Description of the Spectroscope.—Various types of spectroscope are in use. The form used by Bunsen and Kirchhoff consists of the following parts—three tubes, a collimator, a telescope, and a scale-tube placed horizontally with their long axes directed towards the centre of a circular plate, upon which an equilateral flint glass prism is placed with its refracting edge vertical to the axes of the tubes, and parallel with the slit of the collimator. White light, obtained from one of the sources to be mentioned later, falls upon a narrow slit placed in the principal focus of a lens situated at the end of the collimator nearest the prism. The rays of light diverging from the slit are thus rendered parallel, and fall obliquely upon the anterior surface of the prism. The continuous spectrum resulting from the passage of the rays through the prism is viewed by means of a telescope. The telescope consists of an anterior lens directed towards the prism, which forms a real inverted image of the spectrum. By means of the eye-piece of the telescope an enlarged secondary virtual image of the spectrum is viewed by the observer. Fine cross wires are present in the eye-piece of the telescope in order to enable one to localise different parts of the spectrum.

The axis of the scale-tube is placed approximately at right angles to that of the telescope. The photographed scale, consisting of numbered transparent vertical lines on an opaque background, is placed at one extremity of the scale-tube, and lies in the principal focus of a lens situated at the end of the tube next the prism. The rays of light diverging from the illuminated scale are rendered parallel by means of this lens, and then fall upon the post surface of the prism, whence they are reflected into the telescope tube. By means of the telescope an image of the scale is formed in the same plane as that of the spectrum, but situated above it. The scale and spectrum can thus be simultaneously brought into focus by the observer. The spectroscope should also be provided with a rectangular comparison prism placed over the lower half of the slit of the collimator. The light coming from a source placed at right angles to the axis of the collimator falls vertically upon one of the surfaces of the comparison prism, undergoes total reflection at the hypotenuse, and emerging vertical to the third surface, which lies in apposition with the lower half of the slit, passes through the collimator. The upper half of the slit is illuminated by a source of light placed in the direction of the long axis of the collimator. By this means two spectra, situated one above the other, may be examined simultaneously. It is important to remember that, owing to the optical construction of the spectroscope, the spectrum yielded by the light passing through the lower half of the slit when viewed by the observer is seen above that yielded by the light passing through the upper half of the slit. The width of the slit may be varied by means of a micrometer screw. The narrower the slit the fainter and purer is the spectrum obtained; while the wider the slit, the brighter but less pure the spectrum. It is desirable, but not essential, that the edges of the slit should move symmetrically to the median line. In some instruments the slit is divided into an upper and a lower half, the width of each of these being independently adjustable by means of micrometer screws. When provided with the latter mechanism, together with an adjustable slit in the eye-piece, the instrument may also be used as a spectrophotometer. In some forms of the instrument—spectrometers—the scale-tube is replaced by means for accurately measuring the angular displacement of the telescope when it is directed towards different parts of the spectrum. Some types of the instrument are fitted with both these means of measurement.

Another useful type of the instrument is the direct vision spectroscope. The construction of this instrument is based upon the principle that

by using a combination of flint and crown glass prisms it is possible to produce dispersion of mixed light without deviation for some ray of definite refrangibility. The form of this instrument most frequently used is a small pocket spectroscope. The addition of a comparison prism is desirable. In some of the more recent types of small direct vision spectroscope a scale for localising different parts of the spectrum is also present. Larger forms of direct vision spectroscope are also made having a collimating lens, and a telescope which may be rotated so as to view different parts of the spectrum.

Prisms of quartz or rock salt are to be preferred to those of flint glass for the study of the spectrum in the ultra-red and ultra-violet regions. Where these are used the lenses must obviously be of the same material.

Classification of Spectra.—Spectra may be divided into two classes—emission and absorption spectra. The emission spectra may be subdivided into continuous and discontinuous spectra. Solid non-volatile substances heated to white incandescence send out rays of all refrangibilities, and therefore yield a continuous spectrum. Gases or vapours, when at a sufficiently high temperature, emit light of definite wave lengths, and therefore yield discontinuous spectra, which appear to the observer as coloured lines or bands. The position, grouping, and intensity of these lines or bands are determined by the nature of the substance emitting the light, and by the temperature to which it is raised. The spectroscope has been used in this way for ascertaining the rapidity with which lithium reaches different parts of the animal organism after subcutaneous injection

The study of absorption spectra has yielded results of much greater importance in medicine. The substances which show selective absorption for different regions of the continuous spectrum may be in the gaseous, liquid, or solid state. It has been found that at a relatively lower temperature vapours and gases absorb light of the same length which at a higher temperature they emit. It is to this selective absorption of rays of certain wave lengths by the atmospheres of the sun and earth that Fraunhofer's lines owe their origin.

For the study of the absorption spectra of pigments in the solid form, the light reflected from or transmitted through the pigment when transparent may be examined. In the pigment granules certain rays of the white light are absorbed; while the others are reflected from the surface and determine the colour of the substance. On examining with the spectroscope light reflected from the surface of the nail, one can observe the bands of oxyhæmoglobin (Plate, p. 264). If a ligature be then tied round the base of the digit, and after a short time the reflected light be again examined, the spectrum of reduced hæmoglobin will be seen.

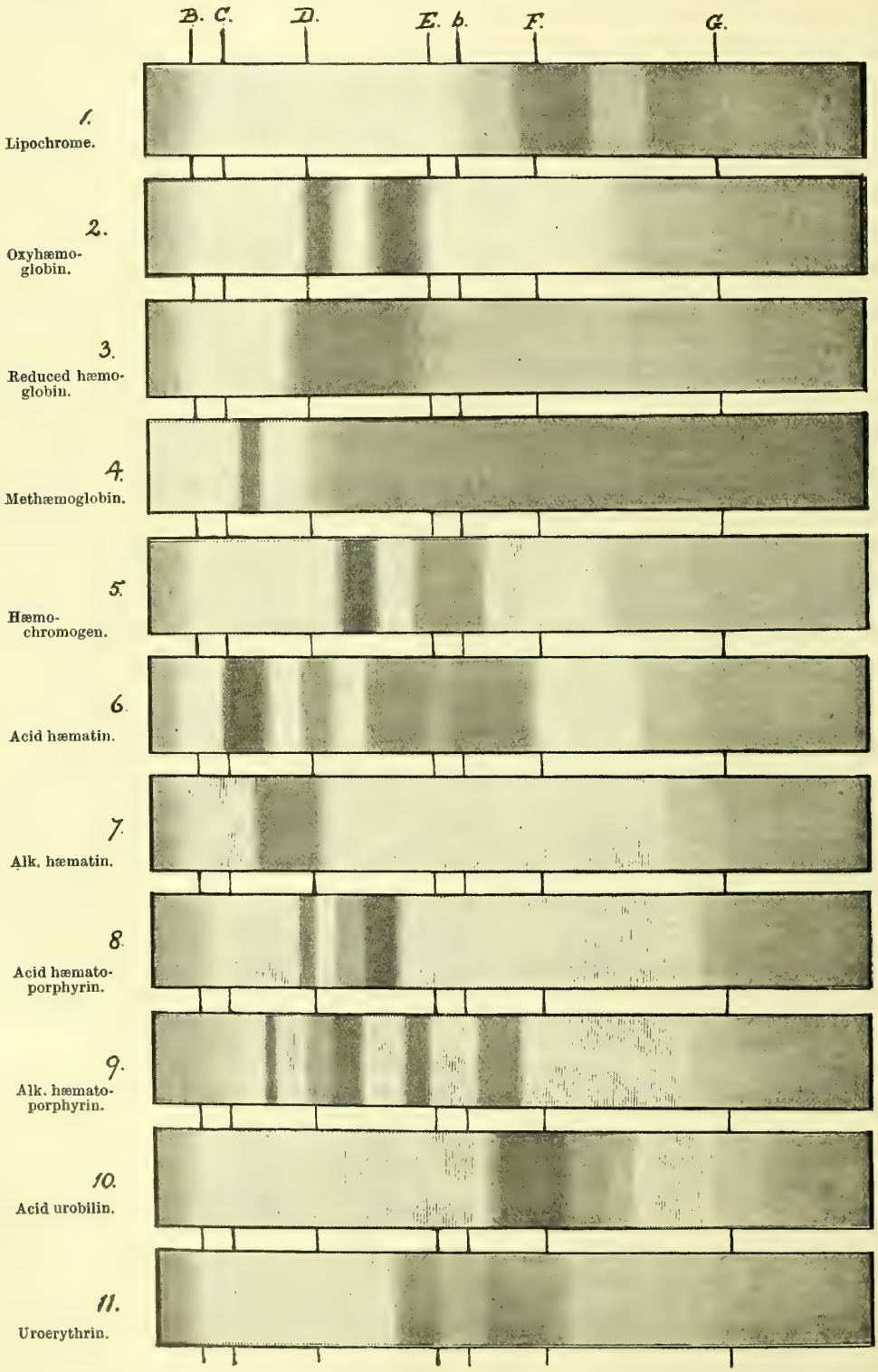
The most important application of the spectroscope in medicine is to the study of the light transmitted through solutions of the pigments derived from the animal organism. A brief account of this subject must therefore be given.

Method of Using the Spectroscope in the Study of Absorption Spectra.—The sun, a luminous gas flame, incandescent burners, the limelight, and the electric light yield approximately white light. Any one of these may therefore be used as a source of light. Before studying the absorption spectra of solutions of pigments, it is necessary to set the scale and prism in position; and secondly, to standardise the scale if it be an arbitrary one. For the reduction of the readings on the arbitrary scale to wave lengths an interpolation curve is necessary.

The scale must be so placed that it extends throughout the whole length of the spectrum, and with D line (or double line) coincident with one of the lines on the scales usually marked 50; while the prism must be placed in the position of minimum deviation for the D line. The chlorides of the metals given later are then introduced into the non-luminous flame of a Bunsen burner, and the position of the bright lines in their emission spectra on the arbitrary scale ascertained. The positions on the scale of the chief Fraunhofer's lines in the solar spectrum should also be ascertained by spectroscopic examination of a beam of sunlight. The following table gives the wave lengths of the lines in the emission spectra of some of the metals, together with the wave lengths of the chief Fraunhofer's lines. The wave lengths, λ, are expressed in millionths of a millimeter (*i.e.* ·001 μ or 1 $\mu\mu$). For medical spectroscopy the statement of the wave lengths in Angström's units (·1 $\mu\mu$) is unnecessary. Potassium chloride, λ 768; A, λ 762; B, λ 687. Lithium chloride, λ 670·8; C, λ 656·3; *a*, λ 627·3. Lithium chloride (orange), λ 610·3; D, λ 589·3. Thallium chloride, λ 535; E, λ 527; *b*, λ 518·3; F, λ 486. Strontium chloride, λ 460·7; *d*, λ 438·3; G, λ 430·8 Potassium chloride, λ 404·4; H, λ 396·8.

In order to convert the position of absorption bands on the scale into position expressed in wave length, an interpolation curve may be constructed in the following way. Along the upper margin of a sheet of paper divided into millimeter squares, the numbers of the arbitrary scale are written according to some fixed standard of measurement, varying with the dispersive power of the instrument used; while the wave lengths from λ 400 to λ 800 are marked along a vertical margin, each millimeter on the paper being made to correspond to 1 or 2 $\mu\mu$ wave length. The position on the arbitrary scale of the chief Fraunhofer's lines and the lines of the emission spectra already given are marked along the upper or scale margin.

Through these fixed points vertical lines are drawn to meet horizontal lines drawn from the corresponding wave lengths on the marginal scale. The points of intersection of the vertical with the horizontal lines are then connected by a curve, the interpolation curve. In order to ascertain the wave length corresponding to any point on the arbitrary scale, it is only necessary



to find out where the ordinate from the corresponding point in the diagram cuts the interpolation curve. The figure on the vertical margin at that horizontal level gives the corresponding wave length. For more complete details reference must be made to works on spectroscopy or on physical optics.

Spectroscopes are also made with a scale on which the wave lengths of absorption bands may be read directly. To set the scale of such instruments the D line is made to coincide with λ 589·3 of the scale.

Cells or troughs, with parallel glass or quartz sides 1 cm. apart, are used for containing the solution of pigments to be examined. For examining the light passing through different fixed depths of layer, a vessel may be employed in which the distance between the parallel glass walls may be varied. Hermann's hæmatoscope may be mentioned as a type of this form of cell. The same end may be attained by the use of wedge-shaped glass vessels.

Description of the Absorption Spectra of some Pigments of Importance in Medicine.—Absorption spectra may be divided into three classes. The first type is that in which there is general absorption without distinct absorption bands. This absorption may be unilateral, involving either the red or the violet end of the spectrum, or it may be bilateral, involving both ends of the spectrum while the intermediate rays are transmitted. Urochrome and bilirubin may be given as examples of this class.

The second type of absorption spectra is that showing more or less definite absorption bands within the visible spectrum. The spectra of pigments belonging to this group may also show more or less general unilateral or bilateral absorption. The type of spectrum showing general absorption is in some cases a banded spectrum in which one margin of the band is situated in the ultra-violet region. For a complete account of the absorption spectra of the pigments in the animal body reference must be made to text-books of physiology. A brief description of the spectra in the chart which Dr. Garrod has given in connection with his article on animal pigments (vol. viii. p. 98) must here suffice.

Spectrum 2 shows the absorption bands of oxyhæmoglobin. The spectrum of carbon oxide hæmoglobin closely resembles it. On careful examination both bands of carbonic oxide hæmoglobin are found to be shifted a little nearer the violet end of the spectrum. Spectrum 3 is that of reduced hæmoglobin obtained by the action of weak reducing agents, *e.g.* ammonium sulphide on solutions of oxyhæmoglobin. The spectrum of carbonic oxide hæmoglobin is left unchanged by the action of ammonium sulphide. These facts are important for the detection of carbonic oxide poisoning.

Figure 6 shows the spectrum of acid hæmatin; while Figure 7 shows that of hæmatin in alkaline solution. Spectrum 5 is that of hæmochromogen, which may be obtained by the reduction of alkaline hæmatin with ammonium sulphide. Very dilute solutions of this pigment show a well-marked spectrum. It is consequently of much importance for the detection of blood stains. Figure 8 is the spectrum of hæmatoporphyrin in a solution containing free mineral acid; while Figure 9 shows the absorption bands of the same pigment in alkaline solution. Figure 1 shows the spectrum of lutein in ethereal solution. Figure 10 shows the spectrum of urobilin in acid solution. Figure 11 shows the spectrum of uroerythrin. Figure 4 gives the spectrum of methæmoglobin.

In conclusion, the influence exerted by the thickness of layer examined, the concentration of the solution, and the nature of the solvent upon the spectroscopic characters of the pigments may be briefly discussed.

The thicker the absorbing layer examined, or the greater the concentration of the solution, the darker and broader do the absorption bands appear. In still thicker layers several absorption bands may become fused into one, and in very thick layers the whole of the spectrum may be absorbed with the exception of light in some particular region. The spectrum of oxyhæmoglobin may be taken as an example. When light transmitted through a thick layer of a solution of oxyhæmoglobin is examined spectroscopically, part of the red end of the spectrum will be seen. On examining a somewhat thinner layer a narrow band of green light appears. Between the red and green regions a single broad absorption band is present. On examining the light which has passed through a still thinner layer, this absorption band is found to have become resolved into the two bands shown in Figure 2.

A full consideration of the laws of the quantitative absorption of light would involve a discussion of the principles of colorimetry and spectrophotometry.

The influence exerted by the solvent on the character of the absorption bands may be physical or chemical. As a general rule, the greater the dispersive power of the solvent the nearer are the bands shifted towards the red end of the spectrum. In the description of the absorption spectra shown in the chart on page 264, several examples illustrating the influence of the chemical reaction of the solutions on the spectroscopic character of the pigments have already been given.

The consideration of the third type of spectrum, namely, that showing sharply defined absorption lines, may be omitted, as none of the known pigments of the animal organism belong to this class.

Speculum.—A mirror, or, more particularly, an instrument, usually made of a reflecting metal, by which the interior of body canals or cavities (nose, rectum, vagina, bladder) can be rendered visible, *e.g.* the Sims' or duck-billed speculum for inspecting the vaginal canal and cervix uteri. *See* Ear, Examination of (*Aural Speculum*); Gynæcology, Diagnosis in (*Vaginal Specula*); Nose, Examination of (*Anterior Rhinoscopy*).

Spedalsked. *See* Venereal Diseases (*Allied Diseases, Norway*).

Spee's Embryo.—An early ovum and embryo described by Graf von Spee; the embryo is 2 mm. long, and its age is supposed to be the second week after impregnation. *See* Embryology.

Speech. *See* Aphasia; Brain, Physiology of (*Functions of Cerebral Cortex*); Brain, Cysts of (*Porencephaly, Clinical Features*); Brain, Cerebellum, Affections of (*Tumour, Symptoms, Speech*); Children, Development of (*Speech*); Chorea (*Symptoms, Articulation*); Cretinism (*Childhood, Speech*); General Paralysis (*Symptoms, Disorders of Motor Control*); Hemiplegia (*Motor Symptoms, Speech Defects*); Myasthenia Gravis (*Symptomatology*); Palate (*Cleft Palate, Effects*); Paralysis (*Cerebral Diplegia, Speech Defects*); Pharynx, Examination of (*Neuroses of Motion, Paralysis of Soft Palate*); Physiology, Respiration (*Voice*); Senile Insanity (*Dementia, Speech*); Stammering; Voice.

Spencer's Operation. *See* Shoulder, Diseases and Injuries (*Operations, Amputations*).

Sperm.—The semen, containing the spermatozoa (*sperm cells*).

Spermaceti. *See* Cetaceum.

Spermatic.—Belonging to the semen or sperm, *e.g.* the *spermatic cord* (*see* Scrotum and Testicle, Diseases of, *Torsion of the Spermatic Cord*).

Spermato-.—In compound words *spermato-* (*Gr.* σπέρμα, that which is sown, seed) means relating to the semen or to the organs and parts concerned in the production or transference of the semen; e.g. *spermatocele* (an encysted hydrocele containing spermatozoa, *see* Fluids, Examination of Pathological), *spermatocystitis* (inflammation of the seminal vesicles, *see* Vesiculæ Seminales), *spermatogenesis* (formation of spermatozoa).

Spermatorrhœa. *See also* Masturbation; Neurasthenia (*Visceral, Sexual*); Scrotum and Testicle, Diseases of (*Sterility*); Vice (*Sexual System*).—The term connotes the escape of seminal fluid when involuntary and incontrollable, as distinguished from the escape of seminal fluid which results from masturbation or coitus.

In many instances, the escape of seminal fluid is a physiological event. Thus in men who practise continence, the nocturnal escape of seminal fluid at variable intervals of time is a perfectly normal occurrence, but it is a matter of difficulty to state what should in general be the shortest period of time intervening between the nocturnal emissions. If the intervals be not less than ten or twelve days, nocturnal emissions should not be regarded as pathological unless there be definite reasons to lead one to form a contrary opinion. In other cases there may be an escape of seminal fluid during the act of defæcation, considerable pressure being exerted upon the seminal vesicles during this act, particularly if the individual suffer from constipation. Seminal emissions are to be considered as pathological when they recur at brief intervals of time, especially when the escape of seminal fluid takes place with little or no erection associated therewith, and when the individual at the same time experiences no sensation of pleasure. The most frequent cause of such abnormal seminal emissions, in other words of true spermatorrhœa, is undoubtedly a long-continued habit of masturbation (*q.v.*), as a result of which debility of the nervous system is induced. A man addicted to this habit may consequently be said to suffer from sexual neurasthenia (*q.v.*), and in such individuals seminal emissions are induced by slight and trivial stimuli.

In certain cases of spermatorrhœa, the condition is aggravated by some localised source of chronic irritation—phymosis, chronic gonorrhœa, chronic prostatitis, chronic cystitis, and intestinal parasites. In other cases spermatorrhœa is merely a symptom of some organic disease of the central nervous system, transverse myelitis for example.

The ill effects of spermatorrhœa are manifested by enfeeblement of muscular and mental power; by inability to undertake arduous or prolonged mental work; by mental depression, lassitude, dyspepsia, and ill-defined pain in the lumbar region.

Treatment.—The most satisfactory results are obtained by treating the psychical and general condition of the patient. Benefit is likely to result if one can induce the patient to desist from masturbation, and can impress on him the fact that his trouble is curable and of no grave significance. The patient should lead an active life, taking a considerable amount of outdoor bodily exercise, so that at the close of the day he experiences a well-marked sensation of muscular fatigue. Gymnastics provide a substitute for outdoor exercise when the latter is not obtainable. The patient should be in-

structed to rise immediately on awaking in the morning, to empty his bladder, and to take a cold bath. Cold sitz-baths are also useful. His diet should not be restricted in amount, but all indigestible and stimulating articles of food must be avoided. Alcohol is only to be taken in small amount, and the patient should be directed not to take a large quantity of fluid late at night. Constipation, if present, must be corrected. Attention should also be directed to the patient's mental state. His mind should be fully employed with some healthful occupation, he should be encouraged to desist from all sexual thoughts, and as it is essential that he obtain sound sleep, it may be necessary to give a hypnotic at bedtime. The administration of drugs is, however, to be avoided as far as possible. Arsenic, iron, strychnine, and quinine are useful in some cases, harmful in others; the bromides, hyoscyamus, or other sedatives are not as a rule required in the treatment of the case. Any source of local irritation, whether it be a phymosis, chronic urethritis, or other condition, should receive appropriate treatment.

When spermatorrhœa is due to organic nervous disease, some benefit may accrue from the employment of such treatment as indicated above, but improvement is in these cases a strictly relative term.

Spermatozoa.—The male reproductive cells found in the semen, and capable of impregnating mature ova. *See* Scrotum and Testicle, Diseases of (*Anatomy and Development of Testis*).

Spermin.—An alkaloid (C_2H_5N), having non-poisonous properties, obtained from semen, sputum, and the organs (*e.g.* the spleen) of leukæmic patients; also, Brown-Séquard's orchitic fluid.

Spes Phthisica.—The hopeful outlook regarding his own recovery taken by the consumptive patient, often when the near approach of the fatal issue is evident to every one else.

Spezzia. *See* Therapeutics, Health Resorts (*Riviera*).

Sphacelinic Acid. *See* Ergot.

Sphacelus.—A necrosed mass or gangrenous part (Gr. σφάκελος, gangrene); sphacelismus is the state of being affected with necrosis. *See* Gangrene.

Sphagiasmus.—Spasm of the neck muscles, especially when occurring in epilepsy (Gr. σφαγή, the throat).

Sphagnum Moss. *See* Balneology (*Peat Baths*).

Spheno-.—In compound words *spheno-* (Gr. σφήν, a wedge), means relating to the sphenoid bone of the skull, or having a wedge shape; e.g. *spheno-maxillary* (relating to the sphenoid and maxillary bones), *spheno-palatine* (relating to the sphenoid and palatine bones), etc.

Spheno-cephalus.—A type of otocephaly in which the lower jaw is defective or absent, the isthmus of the fauces occluded, the superior maxillæ, squamous bones, and zygomatic arches bent towards the middle line inferiorly, and the palate and pterygoid processes of the sphenoid and the tympanic cavities approximated or fused in the middle line; the cranium and organs of vision are well formed, and the mouth exists. *See* Teratology (*Otocephaly*).

Sphenoid. — The wedge-shaped bone (Gr. σφήν, a wedge) existing in the centre of the basis cranii, and having a crest (sphenoidal crest), sinuses (sphenoidal sinuses), and a rostrum (sphenoidal rostrum). *See* Nose, Accessory Sinuses, Inflammation of (*Sphenoidal Sinuses*); Syphilis (*Tertiary, Nose*).

Sphenotribe. — An instrument for crushing the base of the fœtal skull in embryotomy; the operation is known as *sphenotripsy* or *sphenotresia*. *See* Labour, Operations (*Embryotomy*).

Spherobacteria Micrococci. *See* Micro-Organisms.

Spherocephalus. — A teratological type (variety of *otocephalus*) in which the lower jaw is absent or rudimentary, the isthmus of the fauces occluded, the external ears approximated or united, and the bones of the face, the eye, and several other parts absent altogether or very defectively developed.

Spherometer. — An instrument for measuring the curvature of a sphere or of a spherical body (*e.g.* optic lenses). *See* Refraction.

Sphincter.—An annular muscle situated round an orifice such as the anus or the mouth. *See* Asphyxia (*Phenomena, Relaxation of Sphincters*); Brain, Tumours of (*Localising Symptoms*); Brain, Surgery of (*Concussion, Symptoms*); Pelvis, Perineum and Pelvic Floor (*Perineal Tears, Sphincter Ani*); Rectum, Diseases of (*Piles, Associated Conditions*).

Sphincterismus. — Spasmodic contraction of the sphincters, *e.g.* in fissure of the anus.

Sphinctero-. — In compound words *sphinctero-* means relating to a sphincter; *e.g.* *sphincteroscopy* (inspection of sphincters) and *sphincterotomy* (incision of a sphincter).

Sphygmo-. — In compound words *sphygmo-* (Gr, σφυγμός, the pulse, and σφύζω, I throb) means relating to the pulse, *e.g. sphygmology* (the science of the pulse); *sphygmoscope* (an instrument for showing the movements of the pulse), and *sphygmotechny* (the art of diagnosis and prognosis by the pulse).

Sphygmograph. — An instrument for recording graphically the pulse wave; the tracing obtained by this means is termed a *sphygmogram*. *See* Heart, Myocardium and Endocardium (*Physical Signs of Heart Disease, Pulse and Pulse-tracings*); Pulse (*Interpretation of the Sphygmogram*); Physiology, Circulation (*Arterial Pulse*).

Sphygmometer or Sphygmomanometer.—An instrument for measuring the tension of the pulse. *See* Pulse (*Measurement of Arterial Pressure in Man*); Physiology, Circulation (*Pressure in the Arteries*).

Sphyrectomy.—Excision of the malleus of the middle ear (Gr. σφύρα, a hammer).

Sphyrœna. *See* Snake-Bites and Poisonous Fishes (*Fish, Sphyrœna or Barracudas*).

Sphyrotomy.—Removal of part of the malleus, with or without a part of the membrana tympani.

Spica Bandage. *See* Bandages (*Spica Bandages*).

Spiders. *See* Myiasis (*Spiders*); Stinging Insects.

Spiegelberg's Sign.—A peculiar sensation experienced by the finger when it is passed over cancer of the cervix ("as if passed over wet rubber").

Spigelian Lobe.—A small lobe of the liver, named after Adrian van der Spiègel (1578-1625).

Spilus. A mole or nævus (Gr. σπῖλος, a stain).

Spina Bifida.

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See also Aspirator (*Uses of*); Capillaries, Diseases of (*Congenital Angioma, Diagnosis*); Deformities (*Congenital Club Foot, Complications*); Hydrocephalus (*Complications*); Labour, Faults in the Passenger (*Spina Bifida*); Meningitis, Tuberculous and Posterior Basic (*Routes of Infection*); Paralysis (*Infantile Spastic Paraplegia of Spinal Origin*).

Spina bifida is a congenital defect in the development of the spinal canal, and inasmuch as it may exist without any associated tumour, the term ought actually be kept distinct from *meningocele*. The defect in the spine, however, is so generally coupled with a hernial protrusion of the dura mater and arachnoid, and of the cerebro-spinal fluid, and, perhaps, of the cord itself, that the term spina bifida has come to suggest the existence of the more serious defect. Spina bifida, then, almost implies the existence of a meningeal tumour.

A vertebra is developed from three centres of ossification, two for the laminæ and one for the body; these centres appear at the end of the second month of fœtal life. Extending backwards and inwards, the lateral bony plates eventually fuse together in the root of the spinous process. But the laminæ may just fail to meet, in which case there results a narrow fissure in the situation of the spinous processes; this constitutes a simple and unimportant variety of spina bifida. But if the growth of the laminæ be arrested about half-way, a wide gap results —as happens normally at the lower end of the sacral region. In another class of cases the laminæ incline outwards, instead of backwards and inwards, leaving the cavity for the spinal cord merely an open furrow.

When the deficiency in the neural arches is considerable, the spinal membranes, with more or less of their contents, usually protrude and form a soft tumour in the middle line of the back, the tumour being comprehensively termed a "spinal meningocele."

Causation.—As to what may be the exact cause of the arrest of development it is impossible to say. It is quite likely that in some instances it is an increase in the amount of cerebro-spinal fluid within the spinal canal, for the condition is often associated with hydrocephalus. But this would not suffice to explain every variety of the defect—that in which the spinal cord itself remains open and imperfect. Spina bifida and meningocele are simply the result of an arrest of development, just as are hypospadias and syndactylism (vol. ii. p. 283), for the occurrence of which no satisfactory explanation has hitherto been advanced.

The commonest situation of spina bifida is in the lumbo-sacral part of the spine, in which region, it may be remarked, the laminæ are latest in joining. The defect may exist, however, over any part of the canal, from the sacrum to the occiput, several or many of the vertebræ being implicated. The tumour is necessarily situated in the exact median line, and when it is flat and inconspicuous a recollection of this fact is very useful, and may serve

to prevent an incautious operator involving himself in unpleasant or serious consequences.

Complications of Spina Bifida.—Arrest of development in one part of the body is often associated with arrest of development in some other part; so the infant with spina bifida is apt to be miserably small at birth, with, perhaps, an imperforate anus, or extroverted bladder, or a cleft palate, and then, or at a later date, he may be the subject of a hydrocephalus. The serious implication of the nerve-elements may determine paraplegia and various deformities of the legs and feet.

In some cases the integument over the meningeal sac is normal in appearance, but in others it is represented entirely, or in patches, by a thin, translucent epiblastic film, which looks as if it were ready to give way at any moment. And often it does so rupture, with, usually, a fatal result. When the sac of a meningocele or of a myelo-meningocele contains a good deal of fluid, gentle compression of the tumour causes the fontanelles to bulge. And when the intracranial tension is increased by the infant crying, some of the cerebro-spinal fluid is thereby displaced from the cranium and forced into the meningocele, which thus becomes more full and tight. And in some cases the surgeon can cause a fluctuation by gently compressing the tumour with one hand, whilst the other is over the anterior fontanelle.

Varieties of Spina Bifida

1. *Myelocele.*—The spinal cord is developed from the cells of the medullary groove of the epiblast by the medullary ridges curling backwards to meet in the middle line. Thus the earliest spinal cord is a cellular tube blended with the epiblast, but in due course mesoblastic plates growing inwards separate it from the overlying skin. In these plates the laminæ of the vertebræ are subsequently developed (Figs. 3 and 4).

If the medullary ridges duly blend together, in the cervical and dorsal regions, for instance, but fail to meet in the lumbar region, the medullary groove of the embryo cord is left fully exposed. It is covered with indefinite epiblastic cells, and is seen to be narrowing upwards into a funnel-like communication with the central medullary canal (Fig. 1).

"When fresh this area is of a bright red colour and resembles a nævus." The red surface is soft and vascular; it is also raw-looking and moist, the epiblastic cells of the open medullary groove having become detached from its surface.

This species is termed a *myelocele*; it "is fairly common, but it is very rare in museums, because it does not produce a tumour in the loin, and is then regarded as *atypical*, and is cast away." I agree with Mr. Bland-Sutton in regarding this as a common variety of spina bifida.

Many of the subjects of it are born dead, or perish very soon after birth.

2. *Syringo-myelocele* is that rare variety of spina bifida in which the medullary ridges have duly joined, but the original medullary tube (the rudimentary spinal cord) has become distended with fluid, and thus bulges backwards through the neural arch, where it is found adherent to the skin. If large, the tumour would be so translucent as to appear to contain no nerve-tissue—to be a simple meningocele. As a matter of fact, however, the substance of the cord actually forms the lining of the sac, the spinal nerves finding their exit by passing round the convexity of the cyst—obviously, they cannot run across the cyst in their course to the intervertebral notches. Syringo-myelocele is very likely to be associated with paralytic and other defects of the lower extremities and of the pelvic part of the trunk (Fig. 4).

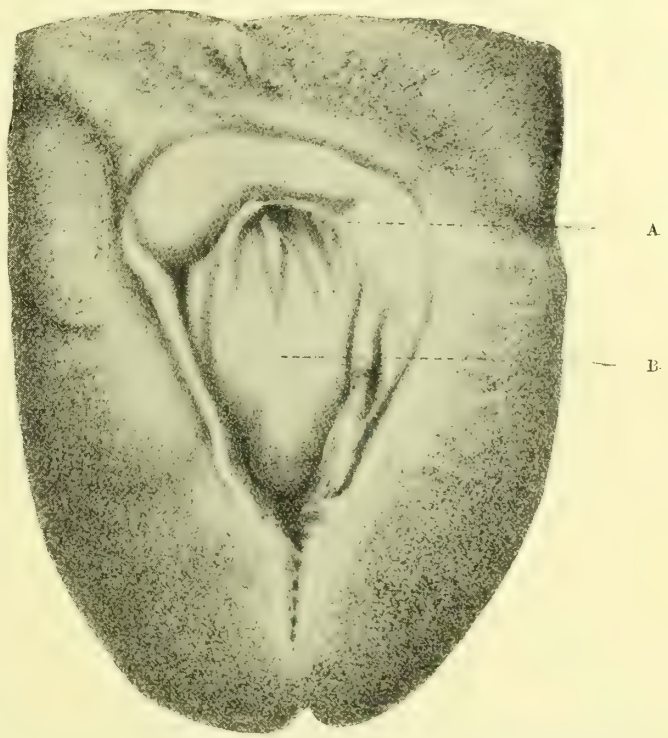


Fig. 1.—Myelocele. Posterior view of the lower part of the trunk of a fœtus at term affected with spina bifida. A, Foramen leading from the outer surface of the protrusion to the central canal of the cord. B, Central or chief part of the protrusion. (Shattock.)

3. *Meningo-myelocele* comes next to the myelocele in order of frequency of occurrence, and it is certainly the commonest variety of spina bifida in those children who survive their birth. In this variety the tumour is formed

by a collection of cerebro-spinal fluid within the dura mater and arachnoid, the cord itself being adherent to the sac posteriorly, and not infrequently causing thereby a longitudinal dimpling of the skin. Sometimes a slight depression of the skin shows the position of the attachment of the very end of the cord. (In a syringo-myelocele such a dimple could not, of course, occur.) (Fig. 2.)

The cord being free in the sac, the nerves have to pass through the cerebro-spinal fluid to reach the intervertebral foramina. In syringo-myelocele, it will be remembered, the nerves coursed on the outside of the sac. This feature, however, cannot be determined until the sac has been opened, either at an operation or at a post-mortem examination. When the meningo-myelocele is in the cervical or dorsal region, the cord quits the lower part of the sac to re-enter the spinal canal. In the tumour the cord is generally adherent to the back of the sac in the median line.

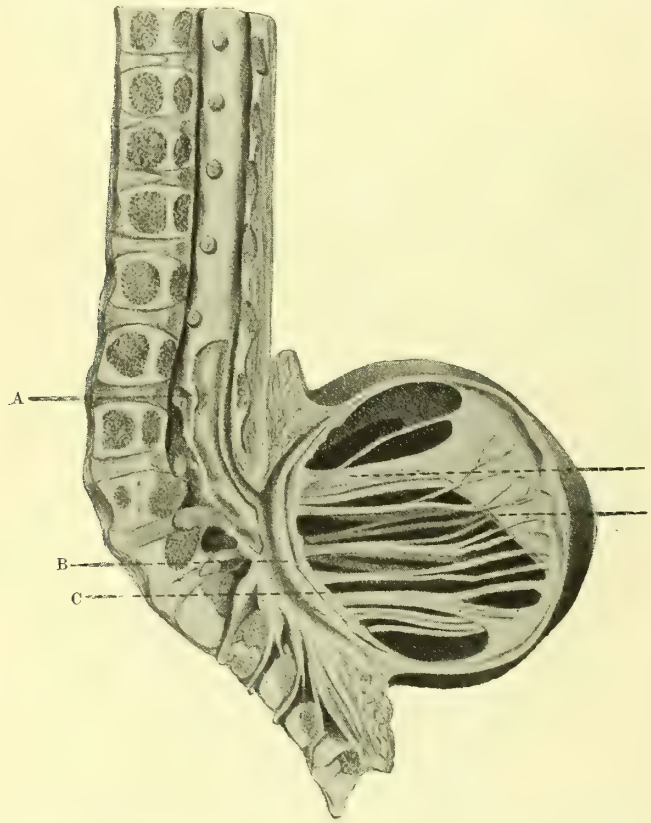


FIG. 2.—Meningo-Myelocele. Dissection of the parts concerned in a lumbo-sacral spina bifida, showing the *typical anatomical disposition* in cases of meningo-myelocele. A portion of the sac-wall has been cut away to show the interior. A, Surface of cord, covered with arachnoid exposed by the removal of dura mater; B, dura mater entering into the formation of the sac-wall; C, arachnoid lining the sac; D, lower portion of the spinal cord crossing the interior of sac; some of the nerve-roots pass forwards upon it, towards the intervertebral foramina. The other nerve-roots arise from the posterior wall of the sac in a vertical series, and traverse the space horizontally. E, Falciform process continuous with the pia mater separating the anterior and posterior roots of the nerves of the left side. (From Report in the *Clinical Society's Transactions*, vol. xviii.)

In some cases of meningo-myelocele the medulla remains in the spinal canal, only the spinal nerves entering the sac.

4. In *meningocele* a protrusion of the dura mater and arachnoid has occurred through the back of the spinal canal, sometimes by a very small gap; the sac is then more or less distended with fluid, but the cord and the nerves occupy their normal course. Many of these cystic protrusions have a slender pedicle, and if, as sometimes happens in the course of growth, the narrow communication with the interior of the canal becomes obliterated, the meningocele may undergo spontaneous cure. In such cases the removal of the tumour would prove a very safe and simple affair.

5. When an imperfect development of the neural arches is unassociated with protrusion of the membranes, or with any other derangement of the spinal contents, the defect is quite unimportant and is likely to remain undetected. This variety of the affection under consideration is termed *spina bifida occulta*. Attention is sometimes directed to the defect by the skin which covers it being coarse, wrinkled, and pigmented, or by its being disfigured by a growth of hair.

But spina bifida occulta may be associated with sufficient disturbance of the cord or the nerves to hinder the course of motor impulses, and consequently to render the lower limbs weak; or there may be such interference with trophic influences as to determine an unwholesome appearance of the skin of the lower extremities, or even of perforating ulcers of the feet.

Results of Spina Bifida.—A simple deficiency of the neural arch of one or more vertebræ may exert no prejudicial influence upon the individual, even when associated with the presence of a tuft of hair (*occulta*), or with a slight protrusion of dura and arachnoid (*meningocele*). But if in the latter case there be also developmental imperfection of the cord or the spinal nerves, there may be functional disturbance of the rectum or bladder, feeble innervation of the muscles of the lower extremities, and trophic disturbances of tissues generally, leading, perchance, to mortification of the toes. Therefore, in cases akin to Raynaud's disease (vol. viii. p. 468) careful examination should be made of the back.

In the case of myelo-meningocele and of syringo-myelocele the effects may be still more marked and serious.

As already stated, the subject of myelocele is usually still-born, or survives but a few days.

Prognosis.—Very few of the subjects of spina bifida with an obvious tumour reach puberty. In most instances the child gradually wastes away and sinks without any active treatment having been undertaken. In others pressure or injury causes sloughing, when, the cerebro-spinal fluid escaping, death quickly supervenes after the intercurrence of septic myelitis and convulsions, or spinal meningitis or myelitis

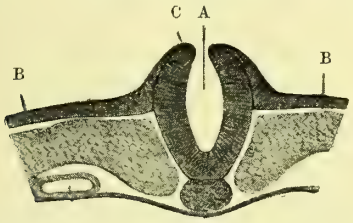


FIG. 3.—Transverse section of an embryo chick of the latter half of the second day, at the place where the vertebral somites cease. A, Medullary groove; BB, epiblast; C, medullary ridge. (After Kolliker.)

may complete the history. Unfortunately the same contingency frequently follows active surgical treatment. But in rare instances spontaneous cure has followed spontaneous rupture of the sac. And in some few cases the sac gradually shrivels up and spontaneous cure takes place, so far at least as regards the disappearance of the tumour; the deficiency in the neural arches of the vertebræ, however, necessarily persists.

Sometimes the spontaneous or the surgical

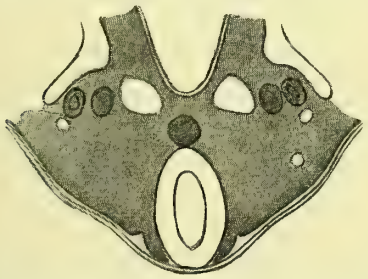


FIG. 4.—Normal disposition of the parts at third day before closure of the vertebral furrow. (After Kolliker.)

cure of the meningocele is quickly followed by the occurrence of a hydrocephalus.

Still, even though the tumour persists, the child may grow up and become a useful member of society, but this is quite exceptional. Very few children with spina bifida and meningocele attain adult life.

Treatment.—Speaking generally, cases of spina bifida do not lend themselves to active surgical treatment, though there are certain cases in which satisfactory results may be hoped for. It is for the surgeon to endeavour to recognise such cases, and studiously to avoid active interference with the others.

Taking the varieties in the inverse order to that in which they have been reviewed in this article, cases of spina bifida occulta may well be left alone. The careful surgeon would cautiously refrain from dissecting away an unsightly patch of skin—perhaps covered with hair—from the middle line of the back, lest by so doing he should wound the adherent dura mater and arachnoid and thus invite the occurrence of an attack of septic meningitis. Indeed, the surgeon should act with extreme caution with regard to all tumours situated in the exact middle line of the back, as in that position the most simple-looking growths are apt to be associated with the interior of the spinal canal.

In the case of a meningocele—especially if it is pedunculated—he can proceed with more hopefulness. Indeed, some of these cases

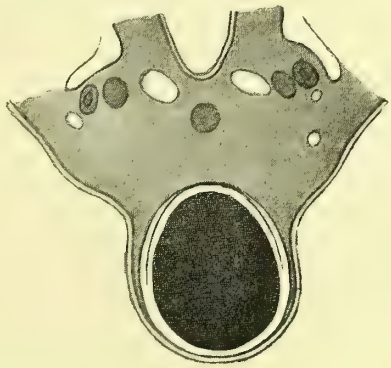


FIG. 5.—Shows dilatation of the central canal of the cord, the nerve-roots passing round its outer surface. Syringo-myelocele.

undergo spontaneous cure. A myelo-meningocele may yield to operative treatment, as will be shown directly, but the syringo-myelocele (which is usually associated with other serious complications) is generally beyond the reach of operative skill, whilst the infant with myelocele scarcely comes within surgical purview.

Treatment by injection is less resorted to now than was formerly the case. It is uncertain in its results, and its adoption is not without considerable risk. The solution usually injected was a drachm of "Morton's fluid," which was composed of ten grains of iodine and thirty grains of iodide of potassium dissolved in an ounce of glycerine. The injection was intended to have such an influence upon the sac as to cause it gradually to shrivel up and become effaced; and this result was attained in a certain proportion of cases. But in other cases persistent leakage of cerebro-spinal fluid at the site of puncture, the entrance of septic micro-organisms, or the direct effect of the local or general irritation proved fatal. Obviously, an irritating injection is as likely to exert its influence upon the delicate cord or the nerves within the sac as upon the spinal membranes.

The cases best suited for the injection treat-

ment were the simple meningoceles, together with, perhaps, the least serious varieties of meningo-myeloceles, and they were to be in the persons of healthy children who were not possessed of any associated complications. These, however, are just the cases which best lend themselves to the more radical and precise method of treatment by excision.

Treatment by excision has now almost entirely superseded that by injection. The method is less blindly speculative; the surgeon sees exactly what he is doing in the course of his operation.

The cases for radical treatment have to be carefully selected:—The child must be well developed and in good general health, and there should be no hydrocephalus, paraplegia, talipes, or any other complication of the spina bifida. And as the operator insists upon these conditions, the myeloceles, syringo-myeloceles, and a large proportion of the meningo-myeloceles are necessarily cast aside as unsuitable for his purpose.

The *radical operation* consists in making a longitudinal incision into each side of the sac (after the manner described by Mr. Mayo Robson). Then, if the sac contain no nerve-tissue, that is, if it be a simple meningocele, the superfluous, median part is cut away and the lateral edges are united by fine sutures. If the cord or any of the spinal nerves be found in the sac, they are to be replaced in the spinal canal, after having been freed, as far as possible, from the wall of the sac. Subsequent to the closure of the sac by sutures the deficiency in the neural arches is to be supplemented by drawing muscular or connective tissue, periosteum, or even flaps from the stunted laminæ, into the middle line, before adjusting the edges of the skin wound over them. This radical method of procedure has not as yet a high-class record. Indeed, considering the very serious imperfection for which it is adopted, this could scarcely be expected. But it is certainly a justifiable operation in suitable cases, and it is based upon a scientific and solid foundation. Under the influence of asepticity it has become a well-recognised surgical procedure, and it has very properly superseded the old-fashioned, speculative treatment by injection. But supposing that a case comes under observation in which, for one reason or another, no active interference is advisable, the surgeon must do his best to protect the tumour from accidental injury by covering it with soft pads and protecting it by a hollow shield. No treatment with collodion, or any other local application, is desirable.

Spinach. *See* Invalid Feeding (*Vegetables*).

Spinal Accessory Nerve. *See also* Brain, Physiology of (*Spinal Accessory Nerve*); Brain, Tumours of (*Localising Symptoms, Cranial Nerves*); Wry-Neck (*Spasmodic, Treatment, Resection of Spinal Accessory*).—The spinal accessory or eleventh cranial nerve is often described as consisting of two parts—an upper, internal, medullary, or vago-accessory portion, and a lower, external, or spinal portion. The latter alone forms the eleventh nerve proper, or nerve of Willis. The upper division is in reality part of the vagus, and will be considered with that nerve.

Anatomy.—The eleventh nerve arises from a nucleus which is situated in the cervical region of the spinal cord, and extends from the medulla as far down as the fifth or sixth cervical segment. The nucleus lies at the base of the anterior horn and towards its outer aspect, forming in its upper part a projection of the grey matter which is known as the lateral horn. The fibres which arise from the nucleus pass outwards through the lateral columns, and appear on the surface of the spinal cord as a series of bundles, the uppermost of which emerge close to the posterior roots, while the lower make their appearance about the middle of the lateral column. The nerve which is formed by the union of these bundles passes upwards through the foramen magnum into the cranial cavity. Its intra-cranial course is, however, short, for it leaves the skull almost immediately by the jugular foramen in company with the glosso-pharyngeal and vagus. Passing backwards it pierces the sterno-mastoid muscle, to which it gives off branches, and then turns downwards to end under cover of the trapezius muscle, to which its terminal branches are distributed. Branches from the third and fourth cervical nerves anastomose with the spinal accessory in this situation, forming the subtrapezial plexus.

Function.—The nerve has a purely motor function; it supplies the sterno-mastoid and trapezius muscles. Both these muscles have an additional supply, the former from the second, the latter from the third and fourth cervical nerves.

Lesions of.—The eleventh nerve may be involved in lesions (*a*) within the vertebral canal, (*b*) within the cranium, or (*c*) in the neck.

The symptoms produced by a lesion of the spinal accessory nerve are purely motor, viz. paralysis of the sterno-mastoid and trapezius muscles.

Paralysis of one sterno-mastoid is said to be unaccompanied by deformity unless a secondary contraction of the opposite muscle occurs. When both sterno-mastoids are paralysed there is difficulty in maintaining the head erect, it tends to fall backwards, and in deep inspiration the muscles do not stand out as they do in health.

If one muscle only is paralysed the head cannot be so forcibly depressed towards the shoulder of that side, and the movement of

rotation of the chin towards the opposite shoulder is interfered with.

Paralysis of the trapezius resulting from a lesion of the spinal accessory nerve is usually incomplete, the reason being that this muscle is also supplied by the third and fourth cervical nerves. The upper part of the muscle may be completely paralysed.

When the trapezius is paralysed the point of shoulder on the affected side hangs lower than its fellow, and the superior angle of the scapula lies nearer the middle line than is normally the case. The natural slope of the neck from the head to the shoulder, which is formed by the upper fibres of the trapezius, is lost; the side of the neck which is now formed by the levator anguli scapulæ muscle is more concave than in health.

When the upper part of both trapezii is paralysed there is a tendency for the head to fall forward, and the shoulders can no longer be raised towards the ears. The vertebral borders of the scapulæ cannot be approximated to the middle line so efficiently as formerly. The scapula does not project from the chest-wall when the arm is held out in front of the body, as is the case in paralysis of the serratus magnus.

Atrophy and associated alterations in the electrical excitability of the muscles accompany the paralysis.

The *diagnosis* of the nature and position of the lesion is to be based upon the history and the associated symptoms. Thus, if the lesion is in the vertebral canal, symptoms pointing to an affection of the spinal cord will probably be present; whereas, if it is intra-cranial, in all probability there will be involvement of the ninth, tenth, and perhaps other cranial nerves. The paralysis is commonly unilateral, but it may be bilateral, as, for example, in progressive muscular atrophy.

Spinal Caries.

See Spine, Surgical Affections of (*Caries*); Syringomyelia (*Diagnosis*).

Spinal Cord.

The surgical affections of the spinal cord and spine are considered later (p. 286).

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See also Alcoholism (*Pathology*); Balneology (*In Disorders of the Nervous System*); Bronchi, Bronchitis (*Etiology, Predisposing Causes*); Deformities (*Compression Paraplegia in Spinal Paralysis*); Deformities (*Rickets, Spine*); Fractures (*Pelvis*); Hysteria (*Spinal Hyperæsthesia*); Hysteria, Surgical Aspects of (*Hysteria of the Spine*); Joints, Diseases of (*Neuro-Arthropathies*); Neurasthenia; Osteo-Arthropathies; Osteomalacia; Paralysis (*Varieties*); Post-mortem Methods (*Head and Spinal Cord*); Pupil (*Spinal Myosis*); Syphilis (*Tertiary*); Syringomyelia; Spina Bifida; Tabes Dorsalis; Teratology (*Malformations of Spine*); Typhoid Fever (*Complications and Sequelæ, Typhoid Spine*); Visceral Pain (*Tender Spine*); Wry-Neck.

Anatomical Considerations.—The spinal cord evidences the metameric segmentation of the ancestral animal more perfectly than does any structure in the human body, and a spinal segment is anatomically defined as a portion of the spinal cord limited by the most anterior (cephalic) and posterior (caudal) fibres respectively of one pair of spinal nerves. Such a segment consists essentially of a mass of nerve cells; of fibres connecting the mass of cells (1) with other segments situated both cephalwards and caudalwards, and (2) with higher parts of the central nervous system; and of afferent and efferent paths (the nerve roots) distributed to all parts of the corresponding somatic segment. The segmentation of the spinal cord does not, however, involve the grey matter, and functionally the segments have lost to a great extent their segmental distinctness. Such functional segmental separation exists to a much greater extent in the thoracic region where somatic segmentation is still apparent than in the limb regions; and throughout the spinal cord it is more marked as regards sensory-supply than as regards motor-supply. As an instance of the great importance of the last statement, it is held that no skeletal muscle receives supply from less than three spinal segments, though it may be supplied by one root.

The sensory areas (*vide* vol. vii. p. 280) which are of the utmost value in localisation of spinal disease are sometimes referred to as segmental areas, but it is obvious, since there is no distinction in the grey matter between the segments, and since from the nature of the grey matter in warm-blooded animals its destruction in one segment interferes with the functional capacity of neighbouring segments situated caudally, that neither experimentally nor pathologically is it possible to deduce the sensory area corresponding with the segment. The "sensory areas" then are either areas of root-supply, or their limits have been deduced from cases of transverse lesions of the spinal cord.

The Grey Matter.—The nerve cells of the spinal cord may be divided into—(1) Those of a markedly angular type, with strong processes and presenting well-marked tigroid granules both in the cell body and in its processes. Such a cell is now regarded as a "motor" cell (*i.e.* a cell upon an outgoing path). (2) Those of a rounded shape with less distinct processes and with but little tigroid substance. Such cells are of the "sensory" type (*i.e.* situated upon an ingoing path).

Whilst longitudinal sections of the spinal cord do not show that the cells are separated into groups, transverse sections reveal a definite grouping in the plane at right angles to the axis of the marrow.

The nerve cells of the spinal cord may be considered in the groups according to their situation—

1. Cells of the anterior horn.
2. The lateral cell column.
3. Clarke's column.
4. Cells of the posterior horn.
5. Cells of the posterior root ganglia and sympathetic ganglia.

The cells of the anterior horn are for the most part large cells of the motor type, their axons leaving the cord as fibres of the anterior roots. They are collected into well-marked groups: (1) Mesial, (2) Ventral, and (3) Lateral. The mesial group is most constant along the whole length of the spinal cord, and from it the dorsal spinal muscles are innervated.

The ventral group supplies the ventral and lateral muscles of the trunk and the respiratory muscles.

The lateral group is mainly developed in the cervical and lumbar enlargements, where it attains very large proportions, and its cells supply the motor fibres for the limb muscles.

The lateral cell column (intermedio-lateral) tract consists of small cells of motor type, and is most marked in the thoracic region, where the chief efflux of vasomotor nerves occurs. It is continuous with the nucleus of the spinal accessory, and the nucleus ambiguous in the upper part of the spinal cord and medulla. From this group of cells the vaso and viscero-motor nerves probably arise.

Clarke's column consists of a well-marked group of large cells, which appear rounded in transverse sections and spindle-shaped in longitudinal sections of the spinal cord; they are conspicuously surrounded by a basket-like network of collaterals from the posterior root fibres, and it is to this group of cells that the terminations of the pyramidal fibres can most readily be traced. It is almost confined to the thoracic region of the spinal cord, being most marked in the lower thoracic region. However, cells of a similar nature and situation are found opposite the origin of the second and the third sacral nerves (Stilling's sacral nucleus), and opposite the origin of the fourth and the fifth cervical nerves (cervical nucleus).

Axons from this group constitute the direct cerebellar tract.

The cells of the posterior horn are not definitely grouped. They are of the sensory type, and are numerous.

The cells of the posterior root ganglia are large unipolar cells of the sensory type. The single process joins the posterior root fibre in a T-shaped junction. Frequently a collateral is given off by this fibre close to the junction to arborise over the surface of the cell. The centripetal process from these cells on entering the spinal cord gives off a number of collateral branches, some of which (short collaterals) descend before breaking up in the grey matter, others pass transversely into the grey matter to form the plexus round Clarke's column, some passing to the ventral horn of the same and of the opposite side. The grey commissure of the spinal cord is made up almost entirely of such collaterals. Other collaterals ascend some distance before entering the grey matter. Finally, after giving off many such branches the posterior root fibre may end by breaking up in the grey matter, or it may run as a long fibre of the posterior columns to terminate in the funiculus gracilis or cuneatus of the medulla. While the majority of the posterior root fibres from the limb regions terminate as long ascending fibres of the posterior columns, it is doubtful whether any such fibres are contributed by the posterior roots in the thoracic region (D 3 to D 12).

The sympathetic ganglia, developmentally considered, are segments of the posterior root ganglia. Their cells are of a similar type, but are multipolar.

The white matter of the spinal cord is most easily described when it is regarded phylogenetically. Commencing at a certain period of its development, we may say that the spinal cord consists of segmented grey matter only. On the surface of this, nerve fibres are laid down, which connect each segment to its neighbour, and later to segments farther and farther removed. There thus arises a system of shorter and longer intersegmental fibres passing in either direction of the spinal axis (intrinsic mediate systems of the spinal cord). From their mode of origin these systems will lie next to the grey matter in the adult cord, and their distance from the grey matter when seen in a transverse section of the cord will be an index of their length, the shorter being nearer and the longer more distant. Later, the various segments of the spinal cord become connected with fibres both ascending and descending, with the medulla, pons Varolii, mesencephalon, thalamic region, and corpora striata in order. Lastly, the development of the pyramidal system places each spinal segment in direct connection with the cerebral cortex, and a more

direct path is established from spinal segments to brain by the development of the long processes of the posterior root fibres which make up Goll's column of the spinal cord. It is of the greatest importance, in considering the effect of lesions of the spinal cord, that one should bear in mind that there are not one, but many paths conducting from brain to spinal cord, and *vice versa*. Let us consider for a space the condition present in some of the lower animals. In the bird, for example, there is no pyramidal system, but the descending fibres from the cortex end in the optic thalamus, which is connected by a well-marked tract of fibres with the spinal segments. In this case incitations travel from brain to cord *via* a junction in the thalamus, that is, by a mediate path. Now, in the human fœtus, and in the infant, movements of the limbs occur before any pyramidal system has reached the spinal cord; the incitations for such movements must therefore reach the spinal cord by some other tracts, such as the rubro-spinal, ponto-spinal, and vestibulo-spinal tracts, which at that period of existence are well developed.

The following mediate paths have been definitely followed in man:—

(1) Descending—

			Tract.
Cortex	Optic thalamus	Spinal cord	Thalamo-spinal
,,	Red nucleus	,, ,,	Rubro-spinal
,,	Quadringeminal region	,, ,,	Tecto-spinal Post. long. bundle
,,	Pons Varolii	,, ,,	Ponto-spinal
,,	Medulla	,, ,,	Vestibulo-spinal

(2) Ascending—

Fibres of Goll's column	Gracile nucleus, etc.	Fillet—cortex
Post. root	Clarke's column	Direct cerebellar tract
,, ,,	Middle cell column	Gower's tract,

and other less important tracts.

By the term tract is meant a collection of fibres of like origin and destination, and not as a rule a definite area of the spinal cord as seen in transverse sections. In the spinal cord the tracts are not distinctly limited (with the exception of the direct cerebellar tract and part of Goll's column), but fibres of several tracts are found together in a particular area of the spinal cord. For example, that region of the lateral column occupied by the lateral pyramidal tract also contains fibres of the rubro-spinal and ponto-spinal tracts both ascending and descending.

Descending Tracts.—The pyramidal tracts. These fibres are the axons of large pyramidal cells situate in the grey matter of the central convolutions of the cerebral cortex. They extend throughout the spinal cord; their terminations have been traced to the region of the cells of Clarke's column, and to the anterior horn. At the decussation of the pyramids each pyramidal tract divides into four parts. The greater number of the fibres cross over and occupy the dorsal part of the lateral column—the crossed lateral pyramidal tract. Some of the fibres enter the lateral column of the spinal cord upon the same side—the direct lateral pyramidal tract. A further set enter the ventral column of the cord, and the majority of these do not cross but lie along the lips of the ventral fissure—the direct ventral pyramidal tract. Others cross to occupy a similar position along the ventral fissure of the opposite side—crossed ventral pyramidal tract. The fibres of the ventral pyramidal tracts are distributed to the cells of the ventral horns only. The proportion in which the fibres are distributed in the four divisions of the pyramidal tract varies greatly in different individuals.

The development of the pyramidal system takes place relatively late, and is not complete in the lower regions of the cord till the end of the second year of life (at the age at which a child learns to walk). When injured these fibres degenerate relatively late.

The rubro-spinal tract (Monakow's bundle) consists of large fibres having their origin in the hinder end of the red nucleus. They soon cross the middle line in Forel's decussation, and lying internal to the sensory root of the fifth nerve come to occupy the angle between the olivary and restiform bodies, and thence run into the lateral column of the cord, where they are at first situated ventral and external to the crossed pyramidal tract, subsequently mixing with the fibres of that tract. They are distributed to the ventral horn of the same side.

The ponto-spinal tracts have their origin in the nuclei centralis and lateralis pontis. One set of these fibres cross the raphé, and, entering the posterior longitudinal bundle, are distributed to the ventral horns with the fibres of that bundle. Others do not cross, and, inclining outwards, join and are distributed with the fibres of the rubro-spinal tract.

The tecto-spinal tract arises in the grey matter beneath the anterior quadrigeminal body, and at once crosses the middle line in Meynert's decussation. It passes down as a compact bundle lateral to the raphé of the medulla, and ventral to the posterior longitudinal bundle. From its

position in this region it is frequently termed the ventral longitudinal bundle. It is distributed throughout the cord to the ventral horns lying along the depths of the ventral fissure. Some of its fibres cross in the anterior commissure shortly before reaching their destination.

The posterior longitudinal bundle (descending fibres) have their origin in the nuclei oculomotorii, some of the fibres crossing in the posterior commissure of the third ventricle, some in Meynert's decussation. Lying on either side of the middle line beneath the grey matter of the aqueduct and fourth ventricle, they sink along the raphé at the decussation of the medulla, and enter the ventral column of the cord. They are distributed to the ventral horns of both sides throughout the spinal cord.

The four tracts last mentioned are the earliest tracts to be developed, and as the result of injury they are the earliest to show degeneration; consequently the products of such degeneration are absorbed relatively early. For example, as the result of a lesion injuring both the pyramidal tract and the posterior longitudinal bundle, at an early period, after such a lesion, the posterior longitudinal bundle might show marked degeneration and the pyramidal tract none, while long after the occurrence of the lesion the pyramidal tract might show degeneration and the posterior longitudinal bundle none.

The vestibulo-spinal tract consists of a large number of fibres, having their origin in Deiter's nucleus in the floor of the fourth ventricle. In the spinal cord they are scattered over the ventral column from the lateral limit of the ventral roots to the depth of the ventral fissure. They are distributed to the ventral horns of both sides, the crossing fibres running in the ventral commissure.

Descending Fibres of the Posterior Columns.— Descending collaterals of the posterior roots.

These extend but a short distance below their origin (at the outside not more than three segments). They lie in close apposition to the mesial surface of the posterior horn, and end in the grey matter of that horn.

Intrinsic descending system of the posterior column.

These fibres are found only below the fourth dorsal segment. Their origin and destination are unknown. Very conspicuously degenerated in transverse lesions, they occupy successively areas in their course which have been termed the comma tract, the cornu-commissure zone, and the superficial crescentic zone, the oval area of Flechsig, the septo-marginal tract of Bruce, the sacral triangle of Gombault and Phillippe.

Ascending Tracts. — Goll's column (dorso-mesial column) is composed of the long processes of the posterior root fibres from the lumbo-sacral region. In the thoracic region it seems doubtful whether any long ascending processes are given off by the posterior root fibres, and in the cervical region the long ascending collaterals do not reach Goll's column, but ascend in the posterior external column to end in the nucleus cuneatus.

The fibres of this tract end for the most part by arborising around the cells of the gracile nucleus. Some, however, sweeping round that nucleus cross the raphé, as internal arcuate fibres reach the inferior vermis of the cerebellum by the inferior peduncle.

Burdach's column (dorso-lateral column) is composed in greater part of the fibres of the entering posterior roots, which after a comparatively short course pass out of the column. The ascending degeneration, therefore, in this column does not extend a great distance above the point of lesion except in the cervical region, where, as has above been mentioned, the long ascending fibres of the cervical roots ascend in the dorso-lateral column to the cuneate nucleus.

The majority of the ascending collaterals of the posterior root lie for several segments above the entry of each root as a compact bundle mesial to the dorsal horn, and constitute the "external root zone" of Burdach's column. Other fibres derived from the posterior roots occupy the dorsal part of Burdach's column, and form the "dorsal root zone," while between these two and the mesially situated Goll's column is a somewhat triangular field—the "middle root zone." The latter is of especial interest pathologically. Its fibres are doubtless of posterior root origin; but, in marked contrast to the fibres of the external and dorsal root zones, and of Goll's column, which are developed before the end of fœtal life, those of the middle root zone are not developed till after birth. Further, they are the first structures to show degeneration in tabes dorsalis, and even in marked cases of the latter disease the pathological changes may be confined to this zone.

The direct cerebellar tract is formed by the axons of the cells of Clarke's column of the same side, and reaches the inferior vermiform process of the cerebellum by way of the restiform body.

Gower's tract arises from cells at the base of the posterior horn, chiefly upon the opposite side of the cord from the lumbar region upwards, and reaches the cerebellum by way of its superior peduncle. It is distributed mainly to the lateral lobe.

The ascending fibres of the posterior longitudinal bundle, of the thalama-, rubro-, and ponto-spinal tracts, accompany the descending fibres of these bundles. Their origin in the spinal cord has not been definitely ascertained.

The central canal of the spinal cord at an early period is oval in shape, with its longer diameter dorso-ventral. At a later period it becomes quadriradiate with a short ventral and

long dorsal ray, and a lateral process on either side which is applied to the posterior horn of grey matter. The short ventral process persists as the central canal in the adult. The lumen of the dorsal process becomes obliterated and forms the posterior septum of the spinal cord. The lateral processes disappear, but the neuroglia originally surrounding them persists as the caput cornu post of Rolando.

The central canal has several interesting pathological connections. Not unfrequently some diverticulum of the central canal is found in the region of the posterior horns or dorsal septum in an otherwise normal spinal cord. The various situations in which hydromyelia and syringomyelia may be found can generally be explained by the persistence of parts of the quadriradiate canal.

Those parts of the fœtal spinal canal which disappear seem to leave along their line of closure a zone of lessened resistance, so that a hæmorrhage of any magnitude occurring in the spinal cord seeks at once the region of the dorsal horn, where it spreads upwards and downwards in the direction of less resistance.

Vascular Supply. — The anterior spinal branches of the vertebral artery, arising from that trunk opposite the 1st cervical root, join to form a single vessel, the ventral spinal artery, which runs throughout the length of the cord lying in the mouth of the ventral fissure.

Arising from the vertebral, close to the former, are the posterior spinal arteries, which run to the lower end of the cord immediately lateral to the dorsal nerve roots.

These arteries are reinforced by a spinal artery entering each intervertebral foramen derived from the vertebral, intercostal, lumbar, iliolumbar, and lateral sacral arteries successively.

The grey matter is supplied chiefly by direct branches from the ventral spinal artery—the white matter chiefly by superficial vessels of the anastomosis.

Physiological Considerations.—Considering the nervous systems of animals from the lowest to the highest, there is an increasing tendency for the subdivisions of the nervous system (for example the spinal segments) to lose their power of individual action and control, and to become mutually interdependent. In man and in the higher apes this is especially the case, and in them the nervous system in these animals may be said to act and react as a whole. When, further, we consider the multiplicity and choice of paths which are present for the passage of incitations both afferent and efferent, we can understand how readily the nervous system, acting as a whole, may partially compensate for the loss of one of its units. Complete compensation occurs only perhaps in the young before the elements are unchangeably impressed with the nature of their functions. It is such compensation which renders the determination of the exact function of certain elements so difficult —for example the basal ganglia of the cerebrum. The paucity of symptoms which result from the partial destruction of these structures is so striking, that it has even been seriously entertained that they are disappearing elements in the nervous system of anthropoids and are practically functionless. Their complicated neuronic structure and their multiple connection with important and better-known elements are facts suggesting a most important function for the basal ganglia.

Three examples of this unity of the nervous system which are of fundamental importance in the symptomatology of nervous disease are necessary here :—

(1) If a pair of electrodes be placed beneath a dorsal root of a monkey, and a single induction shock sent through, there result movements the nature of which is constant for a given strength of current. This reflex result may be taken as an index of a reflex act proper.

If then the central nervous system of the animal be injured in any part, whether cephalwards or caudalwards of the stimulated root, the reflex response to the same stimulus becomes at once changed and constant. With a second injury, again, the reflex result becomes changed and constant, and similarly with repeated injuries. Further, the more the stimulated segment is isolated by such injuries (*i.e.* the smaller the mass of central nervous system left attached to it), the less complex and the more feeble is the reflex result obtained. With reduction of the central nervous system as a whole the reflex response to a stimulus applied to one of its subdivisions changes.

(2) If in the monkey all the dorsal roots supplying a limb be divided, more or less complete paralysis of that limb results immediately. The phenomenon most forcibly illustrates the mutual interdependence of the nerve elements.

(3) While in lower mammals, such as the cat and the dog, after complete transection of the cord, a condition of spasticity results below the point of section, in man and in the monkey such a lesion is followed by great depression of the vital activity of the parts below the lesion ; the muscle tone and myotatic irritability are lost, the sphincters are relaxed, and the superficial reflexes are difficult to retain and reduced in quality. Isolated portions of the spinal cord seem to have lost their capacity for such home rule as is manifest in the lower mammals.

There is a tendency, also, for the elements of the spinal segments so isolated to undergo a slow form of histological deterioration.

Motor Paths in the Spinal Cord.—It is probable that incitations from the cerebrum reach the segments of the spinal cord by all the long descending tracts. One of these only is uninterrupted, the pyramidal tract ; the other thalamo-, rubro,- tecto-, and vestibulo-spinal tracts, and the

posterior longitudinal bundle, are mediate paths. The functional compensation possible between the tracts doubtless accounts for the fact that complete division of the pyramidal tract does not produce lasting paralysis in the higher animals, and that stimulation of the cerebral cortex after such division results in movements of the limbs. The motor path supplies chiefly the crossed side; its uncrossed fibres probably carry incitations for muscles which are habitually used contralaterally. For example, in turning the head the left sterno-mastoid is used with the right splenius capitis, and *vice versa*. Similarly, in lifting a weight, etc., with the right hand, the left erector spinæ is put into action.

The posterior longitudinal bundle and vestibulo-spinal tract serve further to connect the ocular nuclei and auditory nuclei respectively with the spinal musculature; the importance of such connection for equilibration is obvious.

The function of the cells of the ventral horn has been already indicated. The vaso- and viscero-motor fibres leave the spinal cord in the most lateral part of the ventral root.

Sensory Paths. — The path of common sensation reaching the cord by the posterior root seems to divide, touch and cold going together, while heat and pain preserve another path. The exact paths are not known, but that of touch and cold seems to become bilateral shortly after the entrance of the root, while that of heat and pain appears to cross almost entirely at the same level. It is likely that the mesial part of the lateral column is the seat of the conduction of some of these impressions.

The muscular sense is conveyed from the limbs by Goll's column and (for the upper limbs) by Burdach's column to the opposite side of the cerebellum *via* the nuclei graciles and cuneati.

The direct cerebellar tract probably is the muscular sense tract for the trunk muscles. It is an uncrossed tract.

The function of Gower's tract is not definitely known.

For the sensory and motor supply by the spinal roots, see vol. vii., art. "Paralysis."

Shock.—The collection of phenomena indicating depressed vitality which ensues upon injury or violent stimulation of the nervous system, and to which the term "shock" is applied, has been explained as a severe stimulus causing widespread inhibition in the nervous elements, or as a condition of general exhaustion following a great stimulus. Recent experiments as to the nature of shock are of great interest.

It must be borne in mind, in the first place, that every severe stimulus applied directly or indirectly to the nervous system causes, after a temporary rise, a great fall in the blood pressure, and when this occurs general vitality is depressed, for the reason that the circulation of the blood is interfered with, therefore nutrition is not so well carried on. Further, loss of blood and lowering of the bodily temperature may contribute to the phenomena. Those phenomena of shock produced by the three above-mentioned causes act generally over the whole body. There is, however, another important element, "spinal shock," the cause of which is little known, and which occurs when the central nervous system is injured. It is not general in its effect, but is manifest only in those parts supplied aboral to the point of injury, and cannot therefore be due to circulatory disturbance. This phenomenon, little marked although present in invertebrate animals, reaches its maximum in the man and the monkey. An example will render the nature of the phenomenon obvious. If with the least possible injury the spinal cord of a monkey is transected in the upper dorsal region the lower extremities hang flaccid and lifeless. Reflex activity, at first absent altogether, is always difficult to elicit, and little muscle tone ever returns. Above the lesion, however, even an hour after the operation, little or no sign of shock is present, for the animal takes interest in his surroundings, and uses his hands with customary agility in catching flies and peeling chestnuts.

If, again, after some time, when some reflex activity is elicitable, a second transection be made in the upper lumbar region, all reflex action and muscle tone are lost below the second lesion, whilst no alteration takes place in the region between the first lesion and the second.

Further, the manifestation of spinal shock is more complete in those parts supplied by the isolated portion near the lesion than in more distant parts.

It is more severe also the more aborally the lesion is placed.

It would appear as if the phenomena of spinal shock are of the nature of isolation phenomena, due to the severance of paths conducting centrifugal influences necessary for the normal action of the isolated part of the central nervous system.

General Symptomatology.—*Sensory Symptoms.*—The disturbances of sensibility occurring in lesions of spinal cord are conveniently divided into subjective and objective disorders.

Subjective.	Objective.
Pain, general.	Hyperæsthesia.
	Hyperalgesia.
,, localised.	Anæsthesia to touch.
,, dull.	,, cold.
,, sharp.	,, heat.
,, occurring on movement.	,, pain.
Tingling.	,, muscular.
Numbness.	,, faradism.
Psychroæsthesia, etc.	

General dull pain referred to the spinal column apart from that occurring in toxic states is characteristic of neurasthenia. Among diseases of the spinal cord it is very commonly met with in the paraplegic forms of disseminate sclerosis.

Localised dull pain is a more frequent and more important symptom. It is of distinct localising value, and such pain persisting is usually of organic origin. It is of usual occurrence in syringomyelia and intra-medullary spinal tumours (sometimes absent), and is not infrequent in extra-medullary tumours, spinal caries, and tabes dorsalis. It is usually present at the onset of acute myelitis.

Sharp pains occurring spontaneously are characteristic of tabes dorsalis and of implication of the meninges and nerve roots by meningitis or new growth.

Such pains radiating into the periphery suggest implication of the nerve roots, or of the nerve trunks, according to their area of distribution.

Tuberculous spinal meningitis is not infrequently unassociated with pain.

Sharp pain occurring on movement of the vertebral column is characteristic of disease of the vertebral column, or of growth within the vertebral canal, so situated that tension is put upon nerve roots by movement of the spine.

It is remarkable that subjective sensations of pain are referred always to the deeper parts, and never to the skin.

Girdle sensations are characteristic of local lesions of the spinal cord of every kind. They are met with also in tabes dorsalis and in insular sclerosis. Always of great localising value, they mark the upper limit of a single lesion. Their exact causation is unexplained further than that the skin distribution of the nerve roots determines the "girdle." The sensation is described by some patients as one of constriction, by others as one of fulness (as if the skin over the area were not large enough). Similar sensations occurring in the perinæum and limbs are referred to by patients as a feeling of weight, "of constriction," "as if the leg were hide-bound," or simply as stiffness.

Tingling and formication are always referred to the skin, and are common both in diseases of the spinal cord and the peripheral nerves.

Numbness is truly a sensation, and not an absence of sensibility. It is frequently present when anæsthesia is absent, and usually absent when anæsthesia is at all marked. It is referred to the skin.

Psychroæsthesia, a subjective feeling of cold and many similar sensations, such as a feeling of heat, of running water, and vermicular sensations, are occasionally met with. No explanation of the causation is at hand.

Objective Change in Sensibility. — Zones of hyperæsthesia and hyperalgesia are met generally immediately above (sometimes in partial lesions below) the skin region corresponding with the lesion. They have been explained as the result of an increased excitability produced in certain nerve fibres by an inflamed condition of the surrounding tissue of the spinal cord. Such an explanation appears incorrect, since such areas may persist almost indefinitely.

Hypersensitivity is commonly met with in peripheral neuritis, and sometimes in tabes dorsalis.

Anæsthesia may be considered (1) according to its distribution, and (2) its nature.

According to distribution: (1) Nerve root, (2) nerve trunk, (3) nerve periphery in general, (4) glove and stocking anæsthesia, (5) hemianæsthesia.

Special forms: Syringomyelic type, some cases of tabes dorsalis, Brown-Séquard type.

Nerve-root anæsthesia includes all paranæsthesiæ, the upper limit of which corresponds with a root area limit (*see* vol. vii. p. 280). This type, with few exceptions, is that met with in vertebral disease and injury, and in transverse lesions of the spinal cord, extra medullary tumours, and pachymeningitis, and in most cases of tabes dorsalis.

Nerve-trunk anæsthesia follows the anatomical distribution of a nerve trunk. It is nearly always of traumatic origin.

Nerve-periphery Anæsthesia. — This type is met with upon the limbs. All the nerve fibres are affected in proportion to their length, the longest being most affected, so that anæsthesia (usually incomplete) is most marked in the extreme periphery, and lessens gradually as it is traced towards the trunks, while it is equally distributed in the direction of the circumference of the limb.

This type is characteristic of multiple neuritis.

Stocking and glove anæsthesia are distributed in the form their name implies, the upper limits being sharp. When such anæsthesia becomes more extensive and invades the trunk, it takes the form of a sharply limited hemianæsthesia or paranæsthesia.

This type is characteristic of hysteria.

Syringomyelic Type.—In some cases of syringomyelia, hæmatomyelia, central focal myelitis, and intra-medullary growths, the distribution is peculiar and *sui generis*. *Vide* "SYRINGOMYELIA."

Certain cases of tabes dorsalis present peculiar and unexplainable anæsthesia, such as (1) universal analgesia, (2) central part of face alone exempt, (3) neck alone exempt.

Brown-Séquard Anæsthesia.—This was at one time considered to be the typical disturbance of sensibility resulting from a hemi-section of the spinal cord. There is loss of the muscular sense in the half trunk and limb on the same side below the lesion, with a zone of hyperæs-

thesia above the lesion, and anæsthesia to all forms with preserved muscle sense on the opposite side below the lesion. It appears, however, that such a distribution of anæsthesia does not result from hemi-section of the spinal cord in monkeys, and although Brown-Séquard's type is undoubtedly met with clinically, yet it has not yet been proved in any such case that the lesion amounted to a hemi-section. (More commonly unilateral lesions of the spinal cord give rise to anæsthesia upon the paralysed side.)

The Nature of the Sensory Change.—It may be generally stated that a progressive local lesion of the spinal cord affecting all parts of a transverse area of the cord equally (for example, a new growth or tubercular deposit pressing upon the cord) produces subsequently to the onset of a motor paralysis, firstly, loss of temperature sense a short time after loss to pain, and then relatively a long time after loss of tactile sensibility. In other words, the tactile paths seem more resistent to injury than are those of pain and temperature. (The reverse is true of organic cerebral anæsthesia, while in functional anæsthesia neither statement applies.)

It cannot be too strongly insisted that only the most carefully worked-out charts of anæsthesia are of value in diagnosis. The slightest changes in sensibility must be made the limit of the anæsthesia, and minimal stimuli as far as possible should be used. A chart of anæsthesia so prepared may be said invariably to indicate correctly the situation of a focal lesion.

The common spinal type of anæsthesia is that above mentioned—earlier, greater, and more highly distributed anæsthesia to pain and temperature than to touch. This condition must not be confused with dissociated anæsthesia: in the former there is always loss to all forms when anæsthesia is marked, whereas in the latter there is never any loss to touch, though touches may "feel different" over the affected area.

Dissociated anæsthesia with loss to pain and temperature is met with in syringomyelia, hæmatomyelia, and other lesions of the central parts of the marrow, and sometimes in tabes dorsalis.

Rarely there is relative loss to touch and cold only, or to pain and heat only in association with small focal lesions.

In tabes dorsalis the nature of the sensory loss is most varied. There are usually analgesia and thermanæsthesia *pari passu*. Marked tactile anæsthesia is relatively uncommon.

In functional anæsthesia there is generally greater loss to pain than to touch.

In peripheral anæsthesia the loss is usually relative, and sometimes the tactual loss is greater than that to pain, and there may be spontaneous severe pain associated with the tactual loss (anæsthesia dolorosa).

Motor Symptoms—Paralysis.—The slighter forms of loss of power are liable to be overlooked by the physician unless the performance of a somewhat complicated act is taken as a test. It must be remembered that although there may be no direct involvement of the motor elements, there is always loss of power associated with marked anæsthesia, with ataxy, with arthritic affection, and with local pain.

Spasticity, Rigidity, Contracture. *See* "Paralysis," vol. vii.

Hypotonia flaccidity of both muscles and ligaments is a characteristic feature in tabes dorsalis; in the late stages of acute combined degeneration; in the early stages of acute myelitis, and in total transverse lesions of the spinal cord. Strangely it is not a feature in Friedreich's disease nor in those diseases associated with gradual wasting of muscles.

Muscular wasting may be general or local; when general, there is, as a rule, some tonic cause, recent or remote. It is the rule in total transverse lesion of the cord to find marked general muscular wasting below the lesion. The same is true of long-standing spastic paraplegia.

In the last stages of combined degeneration, Friedreich's disease, and disseminate sclerosis, intense general muscular wasting is the rule.

Local muscular wasting may be the result of disease of the muscle or of any part of the lower motor neuron. It is invariably a constant associate of arthritis, the abnormal afferent impulse from the joint apparently causing deterioration of the spinal segment supplying it and alteration of the functional capacity of the ventral horn cells. (Doubtless many cases of arthritis, for example, osteo-arthritis, are associated with actual neuritis, but wasting above mentioned occurs with every traumatic lesion of a joint.)

Muscular wasting most often succeeds paralysis, but in progressive muscular atrophy the two run with level steps. In this disease the lesion involves cell by cell, and so long as there is a normal fibre in a muscle that fibre will contract voluntarily. This point offers a valuable distinction between progressive muscular atrophy and the atrophy of somewhat similar type which occurs in syringomyelia, for in the latter a completely paralysed muscle is frequently met with.

Electrical Reactions (*quo vide*).—Many erroneous impressions exist as to the value of electrical reactions in diagnosis and treatment. The reaction of degeneration is rarely seen except in Bell's palsy, and polar change is of hardly any importance in diagnosis and prognosis. The presence or absence of faradic excitability is, on the other hand, of great importance; for example, in infantile palsy a muscle which responds even in the feeblest degree to faradism within a fortnight of the attack may safely be predicted to recover.

The great variability of the thickness and

conductivity of the skin in different individuals renders accurate investigation difficult. It must be pointed out that clinical electrical reactions are the reactions of muscles covered with skin. If electrodes be placed directly in contact with the muscle, as by using needle electrodes plunged through the skin, no muscle ever fails to respond to faradic stimuli so long as it is muscle and not fibrous tissue. The rapid decrease of and final disappearance of faradic irritability which occurs in myasthenia during the application of a series of stimuli is pathognomonic of that disease, and of remarkable physiological interest in connection with fatigue.

In familial periodic paralysis the transient attacks of palsy are accompanied by complete loss of every form of excitability in the affected muscles, and this phenomenon, which disappears as rapidly as does the paralysis (in a few hours), is likely to fundamentally alter our present conceptions of the nature of muscular contraction.

Ataxy and inco-ordination are terms used loosely for many disorders of movement. The division into static and dynamic ataxy is entirely artificial and furthers no purpose. The complicity of the mechanism for the co-ordination of movement makes division into types unnecessary. Much more valuable is the detailed investigation of the nature of movements and of the subjective difficulty in performing an act which the patient experiences. From the subjoined list of the better-known factors in co-ordination the great extent to which compensation is possible will be obvious:—

An hereditary faculty (a chick, for instance, is born with perfect co-ordination); ocular guidance; vestibular guidance; the muscular sense; the sense of passive position; tactile sensibility; a normally acting motor mechanism.

The last factor is of considerable importance, for a well-performed act and a well-maintained position are produced by good sensory guidance and good motor execution, and the result is perfect co-ordination. If either of the former fail the sum is less. As an example it is difficult to conceive a patient with spastic paraplegia from affection of the pyramidal tracts alone, who is not to some extent ataxic.

Tremor.—Trophic phenomena, herpes, vasomotor phenomena, erythromelalgia, are fully described under such headings.

Organic Reflexes.—The very beautiful physiological mechanism subserving the organic reflexes has been worked out upon mammals by careful experimental investigations. Clinically the disorders of micturition and defæcation occurring with diseases of the nervous system in man cannot be explained on this hypothesis. Certainly the constant irritation of the centres by cystitis, with the effect of the latter upon the bladder wall, must complicate the disorder. It is doubtful, however, whether the mechanism in the human subject is so simple as that above referred to. Making no attempt to explain the human nervous mechanism subserving micturition, a few isolated facts may be here of service.

(1) In an infant of six weeks the spinal cord was completely destroyed below the fifth cervical root (fœture dislocation rupture of cord, and hæmorrhage into the theca), no trace of any nerve elements being recognisable in the necrotic tissue representing the lower segment of the cord. A normal forcible reflex flow of urine resulted from application of cold to the perineum. This phenomenon was observed several times by the writer.

(2) Total transverse lesions of the cord not involving the lumbar enlargement do not give rise to overflow, incontinence, and distended bladder, except perhaps for a few hours after the lesion. The sphincters are relaxed (not completely), the anal reflex diminished, sometimes lost, and the urine constantly escapes.

(3) Persistent retention and overflow are rare in the spastic paraplegia resulting from severe lesion of the cord. These conditions are most often met with in slight forms of spastic paraplegia.

(4) In cases of tabes dorsalis the dysuresis has a great multiplicity of forms. Its nature varies from time to time, precipitancy, hesitancy, retention, and paralytic incontinence often alternating in one case.

A very frequent phenomenon of tabes is residual urine—the bladder is only partly emptied at each act of micturition; the desire ceases, the sphincters close, and the patient is satisfied that he has emptied his bladder, while perhaps 8 to 12 ounces remain. Such stagnating urine predisposes greatly to cystitis.

Reflexes.—It suffices here to enumerate the superficial reflexes of the tendon reflexes, and point out the approximate segments of the spinal cord with which they are associated. A superficial reflex should theoretically be obtained by stimulation of any part of the skin, and is actually obtainable when the skin is hyperæsthetic. Similarly a tendon jerk should be obtainable from every muscle, but the position of a few muscles only lends itself to a ready evocation of the tendon jerk. Easily excitable regions of the skin only are used clinically for the elicitation of skin reflexes.

Superficial Reflexes.—The pectoral reflex, C5-C7; the scapular, C5-C7; the epigastric, D6-D12; the dorsal, C5-L1; the abdominal, D6-L2; the cremasteric, L2; the dartos, L2; gluteal, L5-S1; the femoral, L3; the plantar, L5-S1.

Deep Reflexes.—The scapulo-humeral, C5-C7; the biceps jerk, C5-6; the triceps jerk, C6-7; the wrist jerk, C7-8; the gluteus jerk, L5-S1; the knee jerk, L2-L4; the hamstrings jerk, S2-S3; the tendo-Achillis jerk, L5-S1.

The majority of these reflexes are well known

and in general use. Some, however, of considerable value have been more recently described, and deserve special mention.

The femoral reflex consists in a contraction of the tensor fascia femoris muscle, when the inner side of the thigh or when the sole of the foot is stimulated. It thus forms part of the usual response in the plantar reflex, and may occur as the result of stimulating the sole when no response takes place in the foot.

The scapulo-humeral reflex is of considerable importance as the most easily elicitable "deep reflex" obtainable in the upper extremity. Upon tapping the vertebral border of the scapula with the "tendon jerk hammer" a contraction takes place in the scapulo-thoracic muscles, which, if the myotatic irritability of the muscles be above the normal, affects also the scapulo-humeral, humero-thoracic, and finally the humeral muscles.

The hamstrings jerk is of somewhat rare occurrence. When the quadriceps extensor is paralysed from a lesion of the motor root supplying it, an attempt to obtain the knee jerk causes a powerful contraction in the quadriceps.

Deformities.—Of special interest and importance in the diagnosis of diseases of the spinal cord are deformities of the trunk and limbs which may result from imperfection of development of the nervous system, from contracture, and from paralysis. In some instances a deformity occurs regularly associated with a certain form of disease, yet the actual way in which the deformity is caused is not easily explained; for instance, the kypho-scoliosis so usual in cases of syringomyelia and Friedreich's disease. Some of the more common associations are the following:—Spastic states—Pes cavus; Friedreich's disease—Kypho-scoliosis, contracture, Pes cavus; Syringomyelia—Kypho-scoliosis, "Main en griffe," Pes cavus; Spina bifida—Maldevelopment of digits, etc.; Myopathy—Dislocations, etc.

General Pathological Considerations.—*Developmental Peculiarities.*—There are two main divisions into which conditions of defective development of the spinal cord may be conveniently if somewhat artificially grouped: (1) Those which are the result of some failure in the developmental activity of certain tissues from some cause as yet unknown, such as spina bifida and persistent embryonic cavities in the cord; and (2) Those which are presumably due to intra-uterine fœtal disease, and of such nature are congenital spastic conditions. In the second of these groups the nervous system, since its development is not complete at birth, constantly shows the result either of incomplete development, arrested development, or non-development. A lesion of the central region of the cerebral hemisphere occurring during fœtal life, since the fibres of the pyramidal system are outgrowths of cells situated in that region, will result in non-development of the corresponding pyramidal system if the lesion occurs early in fœtal life. If the lesion occurs later, and if the destruction of the cerebral region be not complete, varying degrees of agenesia of the pyramidal system will result. Further, it has been shown by von Gudden that if in a young animal an organ be removed, when that animal reaches adult life the structures in functional association with that organ will be found comparatively undeveloped, or even to have undergone progressive atrophy. For example, if one eye be removed at birth the corresponding nerve paths and centres in the cerebrum will cease to progress in their development and become atrophied. If destruction of one part of the nervous system occurs during fœtal life, a like result is found in those structures which are in intimate physiological association with the damaged part.

Spina Bifida.—The central nervous system is developed primarily as a nervous thickening in the epiblastic covering of the body running lengthwise. This thickened plate of epiblastic becomes depressed beneath the level of the body surface, and its lateral parts curving upwards unite so that a tube is formed lying beneath the dorsal epiblast of the embryo. This tube is formed and is cut off from the general epiblast early in the region of the head, last in the lumbar region, and forms the spinal cord. Between the primitive tube-like spinal cord and the dorsal epiblast, layers of mesoblastic tissue grow in on either side and unite, and from them are developed the vertebral arches (laminæ and spines) and the spinal meninges.

The varieties of spina bifida represent arrest of this developmental sequence at some stage. They are commonly, moreover, associated with developmental defects involving other parts of the body. (*See also* "Spina Bifida.")

Congenital cavities in the spinal cord are parts of the original quadriradiate central canal which have persisted in addition to the permanent central canal. They are surrounded by neuroglia containing hardly any nerve elements. This tissue seems to retain the characters of the embryonic neuroglia, and further to be especially liable to become the seat of new growths. In this way many cases of syringomyelia and central gliomata of the cord arise.

It appears also that the vessels in the immediate neighbourhood of these cavities are particularly liable to rupture, and that some cases of hæmatomyelia are to be explained on the ground of hæmorrhage into embryonic cavities in the cord.

The terms hydromyelia and syringomyelia have been applied to distended cavities in the spinal cord corresponding with the normal persistent central canal, and not so corresponding respectively. It is, however, impossible in

the majority of cases to determine either from the position or from the character of the lining membrane of a spinal cord cavity the exact mode of origin.

It is also sometimes impossible to distinguish anatomically cavities, the result of long antecedent hæmatomyelia, from those above mentioned.

The term hydromyelia is perhaps best confined to cavitation of the spinal cord unassociated with symptoms.

Traumatic Lesions. — The most frequently occurring traumatic lesion of the spinal cord is fracture dislocation; less commonly concussion, crushing, punctured wounds, and bullet wounds are met with. In cases of fracture dislocation the conditions of the spinal cord and of the vertebræ may be several.

1. The dislocation is momentary, immediate reduction taking place. Little or no deformity of the vertebral canal is found. The spinal cord may present no sign of the lesion, or perhaps a slight narrowing on external examination, while microscopically all degrees of degeneration of the nerve elements at the level of the lesion may be found.

Among this class, cases of every grade of severity are met with, from a case presenting transient symptoms referable to injury of the spinal cord, and lasting a few days only, to cases where the clinical picture is permanently that of total transverse lesion of the spinal cord.

2. The spinal cord is compressed by a displaced fragment of bone, usually by the edge of the body of the vertebræ. The conditions in this case are those of compression myelitis.

3. The spinal cord is compressed by hæmorrhage occurring outside the theca (local or general) or within the theca (general).

4. The spinal cord may be completely broken across or incompletely torn, with much blood extravasation at the same level.

From the nature of the lesions in classes 2 and 3, the vital importance of early surgical interference in cases of fracture dislocation of the spinal cord cannot be too strongly insisted upon.

Vascular Lesions.—It is important to recognise (firstly) that lesions of the spinal cord may be the result of pathological states of the vessel walls. These will be considered here as vascular lesions proper. Secondly, in many diseases the first noticeable pathological changes occur in the immediate neighbourhood of the vessels, and are often confined to a special set of the spinal vessels. It follows that the distribution of these lesions is determined by that of the blood-vessels, while it is probable that some toxic or infectious agent, rather than a change in the vessel wall, is responsible for the pathological condition.

In disseminate sclerosis the patches are often of vascular distribution, but it is very improbable that this sclerosis is determined by disease of the vessels. In combined degeneration also the distribution of the degeneration corresponds more or less with that of certain blood-vessels; it is almost certain, however, that this degeneration is caused by a toxine circulating in the blood.

The difficulty of this subject is greatly increased by the fact that all degenerative and sclerotic changes in the nervous system are followed, after some time, by changes in the vessel walls supplying the degenerate area, and these changes are indistinguishable from those of arterio-sclerosis. For example, the right lateral column of the cord some time after the occurrence of a left hemiplegia will be found to contain sclerosed vessels, while the vessels of the left lateral column are normal.

When, however, shortly after the occurrence of an acute lesion, marked changes in the vessel walls of a chronic nature are found, it is right to consider such vascular changes as responsible for the lesion—for example, acute myelitis.

Hæmorrhage.—Hæmorrhage into the spinal cord and its membranes is a phenomenon of comparatively rare occurrence. It is in the majority of cases the result of injury, or is associated with persistent embryonal cavities in the cord; less often it is associated with the presence of neoplasms in the spinal cord, or with certain diseases in which hæmorrhage is common, such as scurvy, purpura, etc.

It must, however, be remarked that in wasting diseases small multiple hæmorrhages into the substance of the spinal column not rarely occur shortly before death, but it is doubtful whether such hæmorrhages are ever productive of symptoms.

It is a striking fact that hæmatomyelia is not liable to occur under those conditions which predispose to cerebral hæmorrhage.

Embolism is extremely rare in the spinal cord. Infective endocarditis has been the association in most of the recorded cases.

Thrombosis of the spinal vessels is of comparatively common occurrence, nearly all cases of acute and subacute myelitis being of this nature.

The term "myelitis" has survived from the days when a similar pathological condition occurring in the brain was termed acute cerebritis (acute red softening). The use of the term "myelitis" has unfortunately been associated with the retention of an obsolete pathology for the origin of "myelitis" as an inflammatory process. It has long since been proved that acute cerebritis was the result of occlusion of the cerebral vessels, and the terms "cerebral thrombosis" or "softening" are in general use. Spinal thrombosis, on the other hand, has been denied as the explanation of myelitis by many writers of the present day, who, nevertheless, describe lesions of the pons and medulla as

thrombosis and not as "myelitis," which are identical in nature with the lesions of acute myelitis of the spinal cord. Moreover, there are acute infective diseases of the spinal cord (*vide infra*) to which the term acute myelitis is strictly applicable, and these are comparable also to a like condition occurring in the brain, acute infective polio encephalitis (Strümpell).

Thrombosis of the spinal cord is most commonly of syphilitic origin, otherwise its etiological factors are those of arterial thrombosis in general. It may be distributed in small scattered patches over many parts of the spinal cord (disseminate myelitis), or, as more commonly happens, it affects a transverse area of the spinal cord (transverse myelitis).

In the common form the affected area is not sharply limited in the direction of length of the spinal cord, and there are often small separate foci of disease separated by healthy tissue from the chief lesion. The vessels supplying the white matter are those most frequently affected, and the grey matter (supplied from the ventral spinal artery) is very often free from disease. It is also generally true that the white fibres lying next the grey matter tend to be preserved.

Just as cerebral thrombosis may result either in a condition of softening or one of dry necrosis (the two conditions occur in about the same proportion of adult cases, and dry necrosis much more commonly in early life), so does thrombosis in the spinal cord result rarely in softening, commonly in dry necrosis. In the latter condition there may be little change to the unaided eye, the spinal cord being perhaps a little harder and whiter than normal, and on section opaque and granular. In the softened condition the spinal cord in the affected area may be of a semi-diffluent creamy consistency if examined soon after the occurrence of the thrombosis. Long afterwards the softened substance becomes of a cheesy consistency.

Within the affected area the larger vessels lying upon the surface of the spinal cord hardly ever show any change. It is the vessels running into the cord from the last-mentioned arteries that are conspicuously affected, and these show in all their coats the characteristic changes of sclerotic arteritis, and around those which are thrombosed there is usually a scanty and local small-celled exudation. There is no other evidence of inflammatory reaction, and there is never any meningeal infiltration.

As has been above mentioned, the branches of the ventral spinal artery supplying the grey matter are rarely affected.

Thrombosis of the spinal cord, when local, much more commonly affects the lower half of the dorsal region. Among 68 cases observed at the National Hospital, Queen Square, London, the position of the lesion was as follows:—

Cervical region, 10 cases; dorsal region 1-6, 11 cases; dorsal region 7-12, 37 cases; lumbar region, 10 cases.

No adequate explanation of greater tendency of the lower dorsal region to be affected has been brought forward. It has been stated in explanation that this region is less well supplied with blood than other parts of the spinal cord.

Other observers, however, state upon anatomical and experimental grounds that the lumbo-sacral region is the least well supplied with blood on account of the distance of its vessels from the main arterial trunks, and on account of the effect of gravity. It may be pointed out, notwithstanding, that tissues receive a supply of blood corresponding with their bulk and functional activity, and that probably the lumbar enlargement receives a correspondingly larger blood-supply than the lower dorsal region. Further, the writer is unaware that paucity of blood-supply has been proved to predispose to thrombosis, and the situation of a vessel at a great distance from the main trunk supplying it certainly does not predispose to the occurrence of arterial disease.

Toxic Affections.—At the present time our knowledge of the pathology of the nervous system is so limited, that it is impossible to accurately distinguish between toxic and degenerative changes. It may be argued that all primary degenerative changes are of toxic origin, but since in some progressive degenerative diseases, as, for example, Friedreich's disease, the nervous system never attains a perfect condition of development, and in this disease, as in other familial diseases, it would appear that the nerve elements are possessed of a certain subnormal vitality, which is responsible for their imperfect development, and they are endowed with capacity for a certain tenure of life only, towards the expiration of which period they undergo slow degeneration.

The diseases of toxic origin which will concern us here are those in which the nerve cells are chiefly implicated. There is some evidence, however, that the baneful influence of the toxin may in some diseases affect the medullary sheaths especially, and in others the neuroglia, but as yet our knowledge is very scanty.

As the result of acute toxic processes, the changes in the nerve cells affected are very striking and definite. The sequence is as follows:—

The cell swells, and its outline tends to become rounded.

The tigroid bodies decrease in number, lose their regular arrangement, recede to the periphery of the cell, break up, and finally disappear.

The nucleus leaves the centre of the cell, and approaches the periphery; subsequently it may lose its distinctness and its nucleolus, or may even be extruded from the cell.

The protoplasm of the cell acquires an opaque, "ground glass" appearance. It becomes vacuolated, ceases to stain, and its processes break off, and finally it undergoes fatty degeneration and disappears.

In chronic affections, such as progressive muscular atrophy, and in the spinal form of lead paralysis, an entirely different sequence of changes occurs:—

The cells gradually shrink, the nucleus remaining throughout in a central position.

The tigroid bodies lose their distinctness, and the protoplasm and cell processes stain more and more deeply as the cell diminishes in size.

Later, a very small deeply staining mass at the junction of several well-marked processes is all that remains of the cell, and finally both this and the processes disappear.

Great difficulty arises in determining the nature of the cell changes mentioned in the first group, since when a peripheral nerve or when either the anterior or posterior root is injured, similar changes are seen in the anterior horn cells corresponding. It is, then, almost impossible at present to determine whether the actual incidence of the toxine is upon the cell body or upon its processes.

Take for an instance alcoholic neuritis, where the extremity of the longest process of the anterior horn cells in the limb region is affected. Does the poison act upon the ventral horn cell, the nutritive vitality of which being lowered, that part of the cell most distant from the seat of metabolism degenerates? The following facts support this view, that (1) Permanent paralysis and atrophy occur in some cases of alcoholic neuritis, the absence of regeneration of the nerve fibre indicating cell death; (2) All fatal cases of alcoholic neuritis die with bulbar paralysis (Wernicke), and the final so-called "diaphragmatic" palsy is in reality paralysis of respiration in all its details, essentially a nuclear phenomenon.

Does the toxine act upon the peripheral nerve fibres? If so, it has a minutely selective action upon certain physiological groups. The occurrence of peripheral pain, however, in this disease certainly favours the latter view.

It has been suggested that in Landry's paralysis an affection of the pyramid neurons (upper neurons) occurs similar to the affection of the lower neurons in peripheral neuritis.

Degeneration and Regeneration of Nerve Fibres.—When a nerve cell dies partially or completely the nerve fibres arising from it undergo degeneration. The nerve fibre also degenerates when severed from its nerve cell. It is stated as the result of experiment that the degeneration of the nerve fibres occurs throughout the length of the nerve fibres. In the central nervous system of man, however, the stage of degeneration found in a given tract at different levels may vary greatly. It is certain that, as the result of a transverse lesion of the spinal cord, certain tracts degenerate much earlier than others; for example, the descending mesencephalic tracts and Goll's column degenerate early, whereas the pyramidal tracts degenerate relatively late. The phenomena of the process of degeneration in the spinal only differ from those seen in the peripheral nerves, in that since the medullary sheath of the fibres in the spinal cord contains no nuclei, there is no nuclear multiplication. The myelin breaks up into globules of varying size, the axis cylinder fragments, and is no longer visible; the contents of the neurilemma then undergoes chemical change, so that it reduces osmic acid and stains black in the presence of a hardening agent. This reaction, which occurs only with degenerate myelin, is used as the specific test for a degenerate fibre.

Regeneration.—In the peripheral nerves regeneration of fibres, both from the central and from the peripheral ends of a divided fibre, has been abundantly proved. In the central nervous system, on the other hand, while it is probable that nerve fibres do regenerate to some extent, little is known as to the nature of the process. Nor can the prospect of regeneration be considered in the prognosis of any case.

Degenerative Diseases.—It has been above stated that the distinction of the degenerative diseases from toxic diseases is for the most part artificial. The degenerations resulting from chronic toxic states, post-toxic conditions, and premature senility are at present not clearly distinguishable.

The degenerative diseases may be broadly grouped into the neuronic and the non-neuronic diseases. In the neuronic group the degeneration begins primarily in the nervous elements and involves the whole of the affected neuron to a greater or less extent. The term "systemic" diseases has been used for this class, but it has the disadvantage of inferring that the disease is confined to one anatomical or physiological system of nerve elements, and that all the elements of that system may be affected. Only one group of diseases (familial spastic paraplegia and some forms of cerebral diplegia), in which the degeneration is confined to the pyramidal system, can truly be so named. Tabes dorsalis is largely an affection of the afferent system of the posterior roots, but in no case is that system completely or solely involved. Still less is the degeneration of Friedreich's disease confined to a system, and in the nearly allied general paralysis of the insane there is not a physiological unit in the nervous system which may not be involved.

The non-neuronic group is best exemplified by the disease disseminate sclerosis. The incidence and distribution is not determined by

the neurones further than that the white matter is much more affected than the grey matter. The earliest pathological changes are found in the immediate neighbourhood of the terminal arterioles. Since the axis cylinder suffers last at the site of the lesion, and since secondary degeneration occurs very late, if at all, it is certain that the morbid process must commence either in the medullary sheath, neuroglia, or vessel wall. The evidence is somewhat strongly in favour of the medullary sheath being primarily damaged as the result of some fault (probably toxic) in the blood-supply.

Infections.—These diseases are the result of micro-organisms which, gaining access to the spinal cord, usually by the blood-stream, produce focal lesions, in some diseases invariably confined to certain regions of the spinal cord, in others widely diffused or spreading lesions. The morbid process is one of inflammation, and the result local or widely spread necrosis, in some diseases suppurative, in others non-suppurative. Anterior polio-myelitis is the example in which local non-suppurative necrosis occurs. Acute infective myelitis and acute meningo-myelitis are examples in which diffuse necrosis, sometimes of a suppurative nature, occurs.

New Growths.—Neoplasms may arise in the substance of the spinal cord itself (intra-medullary growths) or in connection with the nerve roots and membranes. Intra-medullary growths are commonly sarcomata, less frequently gliomata, and rarely tubercular and syphilitic growths.

It is very rare for secondary growths to arise from intra-medullary tumours, and the spinal cord is hardly ever the seat of secondary deposits from malignant growths elsewhere.

Extra-medullary growths may be situated within the theca, or may be attached to its outer surface, or may involve its thickness. The commonest form is a benign myxoma; sarcomata occur not rarely. Hypertrophic pachymeningitis is probably a form of new growth peculiar to the theca. It is not of syphilitic origin, and is met with, almost with equal frequency, in the cervical, dorsal, and lumbar regions. Lymphadenoma in this situation is sometimes met with. Localised gummata are not common.

Multiple fibromata of the nerve roots are occasionally met with, especially in the region of the cauda equina.

Secondary growths are very common as extra-medullary tumours of the spinal cord; they are usually multiple, and are generally associated with involvement of the vertebræ. Mammary carcinoma is especially prone to affect the spinal meninges.

Compression Myelitis.—When gradually increasing pressure is exerted upon the spinal cord there ensues a physiological severance of continuity of the paths. The conducting tracts are not simultaneously affected by the pressure. Voluntary motion is the first to be lost, then the muscular sense, next the control of the sphincters after common sensibility (pain first), and, lastly, the muscle tone and knee jerks.

In accordance with the degree of pressure and the length of time it has persisted, the effects of the evascularisation which such pressure naturally involves become manifest, and a condition of necrosis, generally of a dry variety, ensues.

The spinal cord may be subjected to considerable pressure, and the condition of the part of the body below the lesion may be one of spasticity, with complete motor and sensory palsy for many weeks and even months before irrecoverable structural changes set in. The onset, however, at any period during the compression, of flaccidity in the paralysed parts, precedes by a few days only the commencement of ischæmic necrosis. The flaccid paralysis indicates total physiological interruption, and the amount of pressure upon the spinal cord necessary to produce this effect must prohibit the circulation almost entirely in the compressed region of the cord.

The effects of compression merit the term compression myelitis, in that both this condition and acute myelitis are the effects of local ischæmia—the former from pressure, the latter from thrombosis. In neither case, however, is there anything approaching the phenomena of inflammation.

"Spinal Dog." *See* Physiology, Neuro-Muscular Mechanism (*Mode of Action of the Neural Arcs, "Spinal Dog"*).

Spindle. *See* Physiology, Cell (*Mitosis, Nucleus*).

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Contusions of the Spine.—Contusions of the spine and the soft parts of the back merit attention, not so much by reason of the injury

itself, but on account of the likelihood of damage to the spinal cord in severe cases. Contusions which appear to be of little importance have been followed by cord symptoms in the course of a few days, and in some instances of severe contusion, where death has followed, the cord has been found completely disorganised by hæmorrhage into its substance. If the cord be not involved, the contusion follows the ordinary course of such an accident elsewhere, except that frequently there are complaints of considerable stiffness in the back extending over a long period. If sensory or motor disorders appear, especially if the action of the bladder or rectum be interfered with, then the case demands a correct diagnosis and additional care.

Sprains of the Spine.—These vary very widely in their severity. Thus in the mildest degree the muscles and their tendinous attachments are involved, and then there is merely a little stiffness and tenderness over the affected area. In severer cases the ligaments may be torn and an extra-dural hæmorrhage may follow, especially if the ligamenta subflava be torn; and many cases of so-called concussion of the spinal cord followed by grave nervous symptoms are due to a temporary crush of the cord at the time of injury, accompanied by some displacement of the bones, these immediately after the accident recoiling to their normal position.[1] The symptoms are pain (aggravated by movement), stiffness, often localised tenderness and discoloration from effusion of blood. The tenderness on pressure is generally found over several vertebræ, and patients complain that they feel extremely weak in the back. Some affirm that it is impossible to stand up. The prognosis of the case depends largely upon whether the cord and nerve roots are injured. In cases of slight sprain the symptoms pass off after a few days. When the injury has been more severe, symptoms of cord-mischief may make their appearance.

The treatment, both of sprains and contusions when uncomplicated, is summed up by rest, frictions or rubbing with sedative liniments, massage, and when the patient gets about, the support of a bandage or strap is useful to him. If there be evidence of injury to the cord absolute rest from the first is essential, and every attention must be paid to the condition of the lungs, the bladder, the rectum, and the prevention of bed-sores. The patient should not get up until the symptoms have passed off. It must not be forgotten that a large proportion of sprains of the spine, especially those occurring from railway accidents, are followed by symptoms of a neurasthenic or hysterical character, and the condition is known as "traumatic hysteria" or "railway spine," but it is better called "railway brain," as in many cases it is a functional affection of the higher cerebral centres.

[1] Thorburn, *Surgery of the Spinal Cord*, p. 12.

Fracture and Fracture-Dislocation of the Spine.—*Fracture of the Spine.*—Fortunately this severe accident is of comparatively rare occurrence. About two-thirds of the cases are fracture-dislocation, and the remaining third are made up of pure fractures and dislocations. The cervical and dorsal spines are almost equally affected by fracture, but in the lumbar spine it is much less common. It is stated that the vertebræ most frequently injured are the fifth and sixth cervical, the last dorsal, and the first lumbar; but in the cervical spine pure dislocation is more common than pure fracture, while the reverse is the case in the dorsal and lumbar regions. Fracture is more common in males than in females owing to the former being more exposed to injury. It is due to direct and indirect violence: direct, such as a blow on the back by the impact of a falling body, or by a bullet; indirect, by forcible flexion or extension of the spine. In about one-eighth of the cases fracture of the arches is found, and this occurs more often than is supposed to be the case. It is important to recognise this, bearing in mind the possibility of the theca vertebralis being punctured by fragments, and of relieving pressure on the cord by laminectomy. In fracture we find:—

(*a*) Fracture of the spinous processes, associated with pain on movement, local tenderness, mobility, crepitus, and alteration of the direct line of the processes.

(*b*) Fractures of the laminæ, in which both laminæ may be separated or only one. In the former event the laminæ may be driven on to the cord and cause compression. The condition is recognised by crepitus, pain, and depression at the site of injury. Separation of one lamina may be caused by a fall on the shoulder or side of the head, and is difficult to diagnose.

(*c*) Fracture of the transverse processes is largely due to gunshot wounds.

(*d*) In some cases of sprains and contusions, in which there are signs that hæmorrhage has occurred in the canal, it is supposed that a fissure of a vertebral body has occurred.

(*e*) The same remark applies to a partial separation of the intervertebral discs. It is possible that one vertebra starts from its place, causing damage to the cord, and then recoil of the vertebra takes place.

(*f*) The bodies of the displaced vertebræ are splintered or partially crushed.

Fracture-Dislocation.—In this injury there is also great damage to the soft parts. Muscles and their attachments are torn, ligaments ruptured, the intervertebral discs partially severed, and much hæmorrhage takes place into the extraspinal structures, and when the antero-posterior common ligament is ruptured into the vertebral canal. As a rule the

meninges escape laceration, but hæmorrhage may occur between the dura mater and the cord; or, what is still more serious, it may occur into the substance of the cord—especially the grey matter—giving rise to hæmatomyelia. The cord may be immediately disorganised by pressure alone, and thence ensue, if the patient live long enough, ascending and descending myelitis.

Symptoms.—It is well to give those common to fracture-dislocation in any region of the spine, and then to specialise according to the region afterwards. Apart from the symptoms usually associated with fracture of a bone, immediately the accident occurs collapse and sometimes loss of consciousness result, and when the patient recovers his senses he finds himself partially paralysed. He has lost control over his sphincters, and cannot move his lower limbs. There may or may not be anæsthesia, and its level varies; sometimes a line of hyperæsthesia separates the normal from the anæsthetic parts. The temperature often rises immediately after the injury, even to as high as 110° or 112°. But in the case of a fatal event it steadily falls, and records of 80° and 75° in the axilla have been noticed. The pulse as a rule follows the temperature. The effect of the shock is at first to entirely abolish reflex action; which is then regained unless the lumbar cord is involved, when it does not return; but otherwise it becomes exaggerated, and when downward degeneration sets in diminishes. The urinary organs at first suffer from shock, and complete retention occurs. Immediately after the injury, if it be above the lumbar region this retention gives place to involuntary or reflex discharges of urine, of which the patient is unaware, but if the lumbar enlargement be involved the urine continually dribbles away. At first there is no change in the urine, except the presence of a little sugar in some cases; but it soon becomes ammoniacal, ropy, and occasionally it is discoloured with blood. When these changes occur very shortly after an accident, and if great care has been exercised in sterilising the catheter and preventing the entrance of bacilli into the bladder, it is quite possible that the change in the urine is of that kind which might be placed under the description of trophic. After a time the bladder walls undergo degenerative changes, becoming discoloured and ulcerated.

Priapism appears immediately after the accident, and particularly in fracture of the cervical and upper dorsal regions. It is never seen when the fracture involves the lumbar enlargement, and it is seldom noticed when the lower dorsal spine is damaged. It is not persistent, and in a case of degeneration descending into the lumbar enlargement it disappears. Defæcation is profoundly altered. The fæces may pass without the knowledge of the patient if they are firm, but if diarrhœa is present the motions run away. Distension of the abdominal parietes, vomiting, hiccough, are met with in cases when the injury is high up.

One of the most fatal occurrences is the onset of acute bed-sores; and the rapidity with which they form, together with the extreme difficulty of arresting them, seems to indicate that they are due to withdrawal of nerve influence upon the nutrition of the parts. They occur most often on the sacrum and lower lumbar vertebræ, but are seen over bony prominences, such as the anterior superior spines, internal condyles, and the ankles. They may come on also at any time during the progress of the case, even when the greatest care is used; and then they are found to be associated with descending degeneration of the cord, and are often a prelude to the fatal ending. Other trophic lesions develop in the extremities if the patient live sufficiently long.

Symptoms Special to various Regions of the Cord.—*Fracture of the Lower Three Lumbar Vertebræ.*—Owing to the fact that the cord terminates at the lower end of the first lumbar vertebra, or at the upper level of the second, the long roots of the cauda equina may escape injury. Complete paralysis is not necessarily present, although it may be partial, due to hæmorrhage. Thus the loss of sensation is sometimes incomplete, although movement of the parts supplied by the lumbar and sacral plexus is lost. Micturition—at first reflex—may after a time become normal, and fæcal incontinence pass off by degrees.

Fracture between the Second Lumbar and Tenth Dorsal Vertebræ.—From this part of the cord the lumbar and sacral plexuses are given off. Paralysis of the lower limbs and of the bladder and the rectum is common, and sensation is partially or completely lost. At first the urine is retained, but it afterwards dribbles away, and the sphincter ani is paralysed. Priapism is absent, and the reflexes are lost, not to be regained. If the injury occur between the second and tenth dorsal vertebræ, in addition to the motor and sensory loss, the abdominal walls are distended, tympanites occurs, and breathing is carried on mainly by the diaphragm; and the power of expelling mucus from the chest is lost. Some of the reflexes may return according to the site of injury, and priapism is seen when the cord lesion is above the sixth dorsal vertebra.

Fracture in the Cervico-dorsal and Cervical Regions.—Occasionally there is an area of hyperæsthesia, due probably to the congestion and irritation of the region just above the seat of injury. Thorburn has dealt with injuries to the spinal cord in this region very thoroughly, and he gives a table to which reference may be made,[1] showing from which part of the cord the

[1] *Contribution to the Surgery of the Spinal Cord*, pp. 2 and 3.

nerve-supply to the muscles of the neck, shoulder, and upper extremities originates. Inasmuch as the cervical nerves run a comparatively long course within the spinal canal, the level of anæsthesia does not correspond to the site of injury, but is generally about one vertebra below it. That is to say, if the anæsthesia corresponds to the level of the seventh cervical vertebra, the cord is probably injured at the sixth cervical vertebra. As a generalisation, according to Thorburn, the higher the mischief extends in the cord through the brachial region the farther will the anæsthesia extend from the ulnar to the radial side of the forearm. Also be it noted that the biceps is the last muscle to be paralysed. In this region, too, is situated the cilio-spinal centre, and contraction of the pupil and narrowing of the palpebral fissure occur, and the pupil does not dilate on pinching the skin of the neck. If the damage is limited to one side of the cord, or the hæmorrhage is unilateral, the pupil is smaller on the affected side. Great alterations of the temperature occur, and the rate of the pulse corresponds.

Fracture-dislocation of the first, second, or third cervical vertebræ is necessarily a fatal injury, but not always immediately. The patient may survive for a short time if the symptoms are due to hæmorrhage, and not to bony displacement.

The Ophthalmoscopic Changes.—In four cases quoted by Thorburn, of crush of the upper portion of the spinal cord, that is, from the third cervical to the second dorsal vertebræ, ophthalmoscopic changes were found in three, and consisted in haziness, want of definition of the discs accompanied by slight distension of the retinal veins; and in most cases in this region the pupils and palpebral fissures are affected.

Prognosis.—Fracture of the spine is an injury of the gravest character, and the larger number of cases terminate fatally, few living beyond six months. But the writer knows of one case that lived two and a half years, in which paraplegia was complete. The usual causes of death, apart from the immediate interference with respiration, are extradural suppuration leading to meningitis, acute bed-sores, cystitis, ulceration of the bladder, and broncho-pneumonia. The duration of life depends upon the region of the cord affected, but the higher it is the sooner the fatal result follows.

Treatment.—The first point is—the removal of the patient from the site of the accident to bed. He should be gently transferred with all possible care on a board covered with a firm mattress or a blanket. The clothes must be cut off and all unnecessary movements avoided in getting him to bed. It is best, if possible, to place the patient on a water-bed at once. For the collapse, stimulants and hot-water bottles may be used, but the danger of sloughing from hot-water bottles must not be forgotten. At least two efficient nurses should be secured who have been accustomed to these cases, and realise the dangers arising from want of cleanliness, undue pressure on any part, and the risks of rough movement. The bladder should be emptied under the strictest antiseptic precautions with a soft catheter. As soon as possible an examination of the back should be made by the surgeon, to note the extent of the displacement. But it often happens that when the patient is placed flat in bed all displacement disappears, especially if the fracture is comminuted. If the paralysis be asymmetrical or incomplete, if displacement be present, and if there be much pain from nerve pressure, an attempt at rectification may be made, but it must not be prolonged, and should be made with extreme gentleness. The method employed is extension and counter-extension with manipulation. If the fracture be high up and the abdominal and external respiratory muscles are not working, great care must be taken in turning the patient on his face lest the action of the diaphragm be interfered with by the pressure of the abdominal viscera upwards. This has been known to cause fatal asphyxia. If the deformity cannot be relieved in the above way by the usual methods of extension and counter-extension with manipulation, extension on an inclined plane may be effectual, but the results of such attempts at rectification have been by no means encouraging, and laminectomy has been employed. When the pressure is due to the laminæ being driven directly down towards the cord this operation is of some service. It may happen that pressure can be directly relieved, and bony spiculæ which have punctured the dura be taken away. But laminectomy does not hold out much hope when the cord has been injured by a fracture affecting the body, for removal of the laminæ does not relieve the pressure in front, and access to the anterior aspect of the cord is almost impossible. Yet, considering the fatal nature of the affection, almost any means of treatment are to be welcomed. The statistics of W. W. White show that 37 operations for fracture performed during the antiseptic era resulted in 6 complete recoveries from the operation and injury, 6 recoveries with benefit, 11 recoveries unimproved, and 14 deaths—a mortality of 38 per cent. Those cases in which the lesion occupied the lumbar region, especially those in which only the cauda equina were involved, were particularly favourable, and so too were those in which fractures of the arches or laminæ existed. It seems that the indications for operation are as follows:—In all cases in which the depression of the spinous processes or laminæ is seen and felt. In some cases in which shortly after the fracture rapid degeneration sets in. If the cauda equina be involved, or the characteristic symptoms of spinal hæmorrhage are present.

Dislocation.—Dislocation of the spine nearly always occurs in the cervical region. A few dislocations affecting the twelfth dorsal vertebra are recorded, and three or four cases of dislocation of the lumbar vertebræ without serious fracture have been confirmed by autopsy. It may be complete, incomplete, or unilateral, the upper vertebra being dislocated forward over the lower one, although backward dislocations have been recorded. The commonest site is at the junction of the fifth and sixth cervical vertebræ. If the dislocation be complete, on examining the pharynx an unnatural prominence may be felt, and there are the usually associated nerve lesions, with rigidity, and a peculiar attitude of the head and neck. If the dislocation be incomplete there may be irregularity of the spinous processes, and there will be stiffness of the neck and partial paralysis. Naturally, dislocation affecting the first and second cervical vertebræ is followed by death, and dislocation about the fifth and sixth cervical vertebræ is soon fatal. So that it is proper in the majority of cases to attempt to replace the parts by means of traction aided by gentle movements of flexion. The friends should be warned that there is a risk of immediate death during the procedure, but it may conscientiously be carried out by the surgeon, who is well aware of the fatal effect of the injury if left untreated.

When the dislocation is unilateral there is stiffness, irregularity of the spinous processes, radiating pain, and the head is flexed and turned to the shoulder on the sound side. The cord symptoms vary in degree according to the amount of pressure and of hæmorrhage.

If an attempt at reduction for partial dislocation be made, rotation should be used in addition to extension and counter-extension. The head should be carried still further in the direction of the injured side, and then gently rotated and bent towards the opposite side, extension and counter-extension being kept up during the whole time.

Railway Spine, or Traumatic Neuroses.—For our knowledge of this subject we are mainly indebted to the writings of Erichsen, H. W. Page, and Thorburn.

By railway spine is meant a functional disorder of the nervous system, or some part of it, in which there is no gross lesion of the spinal cord, but the symptoms simulate organic disease. It should be clearly stated that in the so-called railway spine the injuries to the soft parts do not differ from injuries to similar structures elsewhere, but they are coloured and are markedly influenced by the fact that they are sustained under exceptional circumstances, such as a railway accident—circumstances which are often extremely horrifying to those concerned. The conditions which are included under the term railway spine are by general agreement the following:—1. A simple sprain of the muscles of the back, which may get entirely well; but more often it is followed by, 2. A general prostration or a condition of neurasthenia. It is to be noted, however, that this neurasthenia may come on either with or without the history of definite injury. 3. A state known as traumatic hysteria.

Conditions 2 and 3 are functional disorders of the nervous system, and they must not be confused with symptoms due to inflammatory conditions and degeneration of the spinal cord. The terms railway spine and concussion of the spinal cord are not synonymous, because concussion of the spinal cord is one of the rarest of injuries, and railway collisions do not appear to be in any way specially productive of it. The expression traumatic neuroses seems to cover fairly exactly the disturbance of function occurring in these accidents. To go more fully into these points: 1. A simple sprain of the back gives rise to apprehensions on the part of the patient, because his mental balance is somewhat disturbed by the collision, and to the lay mind the symptoms of a sprain of the back are easily confounded with those due to nerve lesions. For instance, after such an injury there will sometimes be tenderness over the transverse processes, or the spinal muscles will be stiff and the patient feel that he is unable to move freely. When he attempts to stand up he finds his back is weak and gives way, and there are often some hyperæsthetic patches on the skin, which on being touched give him exquisite pain. If in addition he notes that there is some difficulty in micturition and that the bowels are constipated, his apprehensions are increased. But it is to be noted that when examined, and when the hyperæsthetic patches are touched, he moves his back freely; wherein, as Mr. Page rightly says, lies a diagnostic sign of much value; for it serves to exclude organic injury, and is a distinct indication as to the line of treatment to be adopted. If the symptoms of organic nerve lesions have been carefully excluded, and if there be no definite rigidity of the column, the course of treatment is quite clear. The patient should not be allowed to remain in bed, but should have, first, passive movements, and then use the muscles of the back after time has been allowed for repair of the muscular and ligamentous structures. In fact the condition is comparable to that which is found in ordinary lumbago, and so much so that the term "traumatic lumbago" has been given to it. But it will be readily understood that with the imperfect knowledge of the lay mind as to the relative value of back symptoms, and in people of nervous temperament—especially in those who are overworked or have indulged in excesses—the tendency will be to dwell upon the symptoms until the patient glides off into a state of neurasthenia or general prostration; and this state may even come on

without any definite injury, such as a sprain, and it seems to be due directly to nerve shock.

To quote Mr. Page again, he remarks a very singular fact, namely that "in those cases where severe injury, such as fracture or crush of a limb, has been sustained, followed by the usual signs of shock, it is not nearly so common to see the evidences of general prostration afterwards, as in those cases where there was no physical injury, and the immediate signs of collapse were only slight. The explanation of this anomaly lies in all probability in the fact that, in the one case the collapse is dependent on the injury sustained; and in the other the signs of shock are likely to be delayed in their manifestation, being warded off by the excitement of the scene." Thus a patient after a collision may be able to extricate himself, and finding he is uninjured, attends to the wants and hurts of others, and feels nothing until he goes home, when he suddenly collapses. After a day or two he feels better, and then attempts to attend to his work, with the result that he finds that he cannot do it as well as he did. So that, whether there is a definite sprain of the muscles of the back or not, a man may pass into a general condition of hypochondriasis and even melancholia with all its attendant symptoms. And he becomes the subject of "auto-suggestion," or, as Charcot terms it, "traumatic suggestion," and lives in the belief that he is physically incapacitated. And finding that his business is being improperly attended to, and thinking that his nervous system is hopelessly shattered, he drifts steadily downwards.

Traumatic Hysteria.—As an immediate result of the railway accident—even without injury and due entirely to the fright—the patient has a definite hysterical attack, or he may be reduced to a condition of semi-unconsciousness, or be dazed, and may persuade himself that certain things have happened to him which onlookers know not to be the case. Either the hysterical attack or the state of unconsciousness may be followed immediately or at a later period by paresis, or definite paralysis of hysterical origin, and these symptoms are entirely of cerebral origin.

Difficulties may and do arise in the diagnosis of this condition, and unless the diagnosis is quite clear, very serious errors may be made in the treatment. It is essential, too, to be quite clear that the paraplegia is of an hysterical nature and not organic, and if with the paraplegia there be combined hemianæsthesia, with loss or diminution of the special senses on the same side, the diagnosis is fairly clear. In some cases, too, there will be anæsthesia of a limb terminating abruptly at a definite level. Such an anæsthesia is entirely different from that which obtains where the loss of sensation is due to involvement of the spinal nerves, either at their origin or in their course. Severe sensory disturbances come on immediately after an injury, and may disappear with equal rapidity; but there can be no doubt that to the patient they are extremely alarming, and then the phase of auto-suggestion comes into play, and we have the clinical picture of hysteria. But it must not be supposed that the patient is a malingerer because he is thus affected. To him the symptoms are very real, and his exact condition is that he cannot will to carry out functions which are only temporarily in abeyance.

Since the question of compensation almost invariably comes to the front in these matters, the patient often feels worried as to the amount he is legally entitled to. He is often apprehensive of the publicity of an action, while the necessary examinations by surgeons concentrate his attention on his condition. Therefore, it is not to be wondered at that a very fair proportion of such patients get well immediately the question of compensation has been arranged, and the kindest form of treatment is that which will induce the patient to come to as speedy a settlement as possible of his claims. It will be gathered from what has been said, that it would be very unfair to suppose that because the symptoms improve after the settlement of the claim the patient is a malingerer; for cases are recorded where such patients have steadily gone down hill, and death has supervened from exhaustion. Such a case is recorded by Thorburn.[1] At the same time the possibility that an unjust or excessive claim is being made on insufficient grounds should always be borne in mind by the medical expert, and much acumen and wide experience are needed to detect attempted frauds. The treatment of so-called railway spine is readily summed up. Sprains of the back should be treated on the lines usual for sprains, while if nerve symptoms supervene soporific and narcotic drugs, such as bromide of potassium and morphia, are best avoided. Change of scene, fresh air, abundance of good food, and massage, a proper amount of rest, together with the removal of the worry incidental to the question of compensation, often work wonders.

The Lumbar Plexus.—The *lumbar plexus* is formed by the anterior primary branches of the first, second, third, and half the fourth nerves, and they do not interlace, but arise by two roots from two neighbouring spinal nerves. It may be irritated or compressed by injuries of the psoas, severe sprains of the back, and by tumours of the vertebræ, and its upper part by an aneurysm of the descending aorta. It may also be irritated by a psoas abscess. Its branches may be injured in fracture of the pelvis, by bullet-wounds, sprains, contusions, and fractures of the lower extremity. They may be compressed by pelvic tumours, and the obturator nerve by an obturator hernia. If

[1] *Contribution to the Surgery of the Spinal Cord*, p. 223.

the anterior crural nerve is paralysed there follow loss of movement and wasting of the quadriceps extensor with inability to extend the knee, and there is loss of the knee reflex. The power of flexion of the hip is weakened owing to paralysis of the sartorius, pectineus, and iliacus. Sensation is lost over the cutaneous areas supplied by the middle and internal cutaneous and by the long saphenous nerves. In paralysis of the obturator nerve there will be loss of action on the part of the adductor muscles and wasting, so that the patient cannot put the affected limb across the opposite knee, nor is he able to ride, and there will be anæsthesia of the inner surface of the thigh.

The SACRAL PLEXUS is formed by one-half of the fourth lumbar nerve and the fifth lumbar and the upper four sacral nerves. It may be contused or torn in fractures of the pelvis and compressed by growths from the lumbar and sacral vertebræ, and by intrapelvic growths and inflammatory exudations. It may also be injured during parturition, whether forceps are employed or not, and neuritis of it or its branches may arise from gout, diabetes, or alcoholism.

Paralysis of the Sciatic Nerve.—This may be injured in dislocations of the hip, fractures of the femur, by bullet and knife wounds. The symptoms vary according to the situation of the nerve lesion. If it be high up there are paralysis and atrophy of the biceps, semimembranosus and semitendinosus, and paralysis of the external and internal popliteal nerves which supply the muscles, and loss of much of the sensation below the knee. The external popliteal nerve is more frequently paralysed than the internal popliteal owing to its anatomical course and to its being more exposed.

Paralysis of the Gluteal Nerve.—This is due to much the same conditions which give rise to paralysis of the sacral plexus, and the symptoms consist of paralysis and atrophy of the gluteal muscles, together with the pyriformis and tensor vaginæ femoris. The patient loses the power of forcible extension at the hip joint when it has been previously flexed, also of abduction and circumduction of the hip, and owing to paralysis of the tensor vaginæ femoris the foot is turned outwards when the leg is swung forwards in walking. Paralysis of the external popliteal nerve gives rise to a loss of power in dorsi-flexion of the foot, eversion of the ankle, and extension of the toes. Talipes equinus may follow, and owing to contraction of the unopposed interossei there will be flexion at the metatarso-phalangeal joints. Anæsthesia, vasomotor and trophic changes, are also noted. Paralysis of the internal popliteal nerve causes loss of power of standing on the toes and of inversion of the ankle, so that talipes calcaneovalgus may result, and the toes become hyperextended at the metatarso-phalangeal articulations, and flexed at the interphalangeal joints. Similarly, as in the case of the external popliteal nerve, anæsthesia, vaso-motor and trophic changes ensue.

Lateral Curvature or Scoliosis

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Definition.—Lateral curvature or scoliosis is a rotation of the vertebræ round the vertical axis, frequently, but not necessarily, combined with lateral deviation or bending of the spine to either side.

Etiology.—Its incidence is particularly great in large towns, and amongst the out-patients at a hospital for deformities it is seen in one in about seven to ten other cases. It is more prevalent in girls than in boys according to Kölliker, in a proportion of five to one. Lateral curvature is mainly a disease of adolescence, and there is no doubt that some cases are distinctly hereditary. One case which came under the writer's notice was a boy aged six with a long **C**-curve to the left over the whole dorsal region.

Clinical Aspects.—There are two conditions which are generally included, and wrongly so, in the term lateral curvature. The first is lateral deviation of the spine, in which there is no rotation; and the second is scoliosis, or lateral deviation with rotation. Pure lateral deviation is due to the insufficient support by the muscles of the segmented spine, which gives way, and insensibly a deviation to one side or the other occurs. It is often marked, too, in those people with one leg shorter than the other, but the following distinctions between lateral deviation and scoliosis should be remembered. On flexing the spine in lateral deviation the deviation disappears, but in scoliosis the distortion becomes more apparent. When the patient assumes the horizontal position lateral deviation disappears, but in scoliosis the deformity partially remains. On voluntary muscular effort the spine can be straightened temporarily in deviation, but not so in scoliosis; and on suspension lateral deviation disappears, while in scoliosis the deformity is removed in initial cases only. Finally, in lateral deviation the raised shoulder and the depression just above the crest of the ilium are on the side opposite to that on which the spine deviates, but in scoliosis they are generally on the same side. Such, then, are the main points of distinction between the two

conditions, but it must be remembered that lateral deviation is generally, but by no means always, an antecedent condition to scoliosis—that is, the rotation of the bodies of the vertebræ is superadded to the lateral flexion of the spine.

With reference to the clinical aspects under which scoliosis is met with, a convenient classification is the following:—(1) Cases in which the curvature is mainly unilateral, or the C-shaped curve. The curve may be of small extent, or it may be so large as to involve the dorsal and lumbar regions of the spine. A large C-shaped curve is always of serious import



FIG. 1.—A case in which the vertebral column was affected in two regions by Pott's disease.

because of the number of vertebræ implicated, the general muscular weakness associated with it, and the harmful influence of the weight of the head and upper extremities tending to increase the curve. These cases run a more rapid and less favourable course than others to be described presently. (2) Cases in which two nearly equal curves are present. As a rule the curvature is to the right in the dorsal region and to the left in the lumbar region. It is essential to determine which is primary before suitable treatment can be initiated, and it may be safely said that the less mobile is the primary and more important curve, and therefore demands particular attention. In some cases of these S-shaped curves the dorsal convexity is to the left and the lumbar convexity to the right. But, as just stated, the reverse condition is more common. That it is so is largely dependent upon the excessive use of the right arm, especially in certain employments and occupations, these being such as to elevate the right shoulder and depress the left; and one great cause is undoubtedly faulty posture at school and improper school desks. (3) In some instances three or four distinct curves are seen, and are variously distributed in the spine. In that form of scoliosis in which there is one large curve present there are sometimes two



FIG. 2.—Scoliosis of old standing, associated with adenoids. (Olive B——, aged 9 years, seen at the Evelina Hospital for Sick Children.)

smaller compensatory curves, but this condition is distinct from that now under consideration, in which the curves are often of equal length, and it is difficult to say which one is primary. In this form of scoliosis the accompanying distortion in the chest is less than in those cases where one large curve or two equal curves are present. (4) Scoliosis associated with posterior projection of some of the spinous processes. This condition is seen when the back presents two curves nearly equal, and the projection is always found at the spot where the two curves intersect. The chief interest of this class of case lies in the fact that they may be mistaken for a curvature from Pott's disease, but the mobility of the spine in scoliosis

will at once distinguish them. (5) Scoliosis with obliteration or lessening of the natural antero-posterior curves of the spine. The clinical importance of recognising this group is considerable, because the most important factor in the deformity is excessive rotation in the vertebræ without much lateral deviation, and in these cases the external curvature of the spinous processes is no measure of the extent of the internal displacement of the bodies.

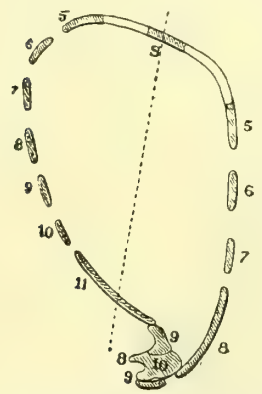


FIG. 3.—Diagram to illustrate the position of the ribs when the curvature is to the right in the dorsal region. (After Rédard.)

The Appearance presented by a Patient with Lateral Curvature. — Inasmuch as the vertebral column, like the keel of a ship, is the foundation of the structure of the trunk (Fisher), the result on the trunk must be very considerable. The mechanism may be grasped by attention to the following diagrams (Figs. 3 and 4), and for the purposes of description we will take the case in which one curvature is to the right in the dorsal region, and there is a second or smaller curve to the left in the lumbar region. The symmetry of the body is lost, the right shoulder being elevated and the left depressed. The right arm is closely approximated to the side, and the left falls away at a considerable angle. The ribs on the right side are bulged posteriorly and depressed anteriorly, while on the left side the reverse is the case. On the right side there is considerable hollowing out of the flank, with prominence of the hip; while on the left the flank is flattened and the hip is less in evidence than usual. These changes are due to rotation of the bodies of the vertebræ, the right transverse processes being rotated backwards in the dorsal region and the left transverse processes in the lumbar region. The obliquity of the right ribs is very marked, so that the scapulæ may be found altered from the natural positions. Thus the right scapula—that of the out-growing shoulder—is raised and is less vertical, and in severe cases becomes almost horizontal, so as to give rise to the impression that its inferior angle is dislocated. It is also farther away from the mid-line than normal. The left scapula appears to have sunk, and its position is just the reverse of the right. The clavicle on the right side is much curved, and in severe cases dislocation of its sternal end has occurred. As the right transverse processes in the dorsal region rotate backwards the spinous processes sink, and they are twisted away to the left, that is, towards the concavity. But the deviation of these processes is no measure of the rotation of the bodies, which is often much greater than appears on the surface owing to the vertical axis of rotation being situated considerably nearer the tips of the spinous processes than the fronts of the vertebral bodies.

In a severe case of the kind we have alluded to, the pelvis is much deformed, the lumbo-sacral angle points to the left, and encroaches to a marked degree on the left half of the cavity. There is also inward displacement of the left acetabulum, and the wing of the sacrum and of the ilium on the left side are thickened. On examination of the softer structures it will be found that the left mamma is very prominent and the umbilicus is displaced to the left. The effect of the distortion of the vertebral column on the shape of the thorax in severe cases is profound. On the convex side its convexity is markedly decreased, and both the antero-posterior and transverse diameters are diminished, but its depth is increased slightly. On the concave side the depth is lessened, but the diameters are increased. A horizontal section of the thorax (*see* Fig. 4) shows it to be elliptical in shape, the longest axis being from the most prominent part of the ribs behind to the opposite nipple in front. That is to say, the ribs on the convex side are doubled up, and those on the concave side are unfolded. After a time the viscera undergo changes in shape and position. With a curvature to the right side in the dorsal region the chest is less resonant and the vesicular murmur is decreased, while on the concave side the reverse obtains. But the total effect is a decrease in the respiratory capacity, so that these patients suffer from frequent and severe attacks of bronchitis. The trachea and bronchi are deviated to the left, and the œso-

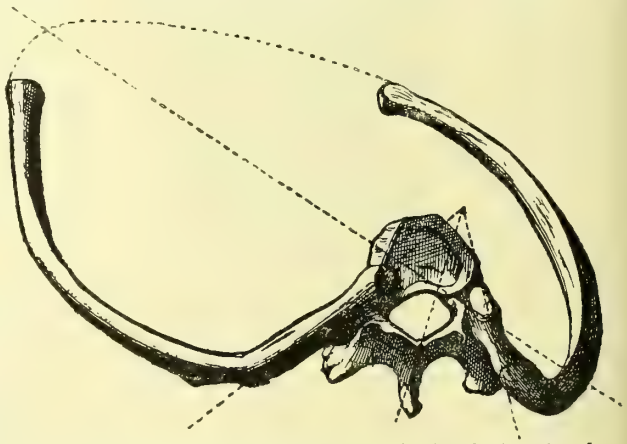


FIG. 4.—Illustrating the alteration in shape of the ribs, the deviation of the transverse diameter of the thorax. (After Rédard.)

phagus in a pronounced case no longer follows its natural direction, but makes a right line for itself. In well-marked cases, and where the concavity is to the left in the dorsal region, the heart's apex is generally above its normal position and displaced outwards. The writer has seen the apex in an extreme case of scoliosis beating in the third intercostal space. The liver, from its large size, is compressed and displaced downwards. The spleen, too, is pushed downwards, while the stomach and intestines are projected forwards to compensate for the lowered position of the diaphragm. Such is the picture presented by cases in which the distortion has developed rapidly and is becoming extreme. But it should not be inferred that all cases present so much functional and structural disturbance as has been described. Many of them are fairly robust and healthy, and suffer in only a slight degree from general ill-health. Others, however, have their lives rendered miserable by impaired circulation, feeble digestion, and limited powers of respiration.

With regard to the muscles of the spine, in an early stage those on the convex side are somewhat prominent, mainly because of their position on the convexity of the curve and the tension of their fibres resulting from a persistent effort to maintain the body equilibrium. After a time the muscles on the concavity become rigid and prominent on account of the shortening they undergo, but as a rule the muscles on the convex side are the weaker ones.

Varieties and Causes of Scoliosis.—The causes of scoliosis may be grouped as follows:—The predisposing and the approximating.

The predisposing causes are those which are constitutional, such as debility, rickets, or a condition of lack of resistance in certain of the vertebræ.

The approximate causes, which are really local, are those which disturb the equilibrium. They are vicious positions in standing or sitting, faulty attitudes, empyema, inequality in the length of the limbs, unequal use of one arm, torticollis, and astigmatism. But this classification does not quite cover all the ground, and the one which is suggested is as follows:—

1. *Primary.*—(*a*) Congenital scoliosis. (*b*) Scoliosis of adolescence, including occupation scoliosis. (*c*) Rachitic scoliosis. (*d*) Scoliosis of nerve origin, *e.g.* scoliosis ischiatica, and that form of scoliosis which is met with in locomotor ataxia, Friedreich's disease, and syringomyelia, and more often in infantile paralysis. In infantile paralysis the convexity of the curve is always toward the side of the paralysed muscles, and this form of nerve disorder is productive of a most intractable variety of scoliosis.

2. *Secondary.*—(*a*) Static scoliosis, that is, distortion due to faulty positions in standing or sitting, and inequality in the length of the limbs, torticollis, and astigmatism. (*b*) Scoliosis due to cicatricial contraction of the chest, such as empyema. (*c*) Scoliosis in connection with nasal and post-nasal obstruction, and such as is seen in well-pronounced asthmatics.

To enlarge upon these headings: and commencing with the scoliosis of adolescence, including occupation scoliosis. It is convenient to group under this heading that large number of cases which, commencing in childhood and youth, and being associated often with muscular debility, are induced or aggravated by unsuitable occupations, such as dressmaking, nursing, carrying weights on one arm, needlework, and book-folding. One of the most fruitful causes is long school hours, and faulty attitudes in sitting and writing, and there is no doubt that teaching children to write the Italian hand is responsible for many a curvature. Sometimes the right hand and forearm are on the table guiding the pen, while the fingers of the left hand merely touch the table, and the shoulder is depressed, with the result that a rotatory curve to the right is produced. At other times it is the left hand and forearm which are placed on the table, and the right arm is unsupported and the right shoulder is depressed, and then there is rotation to the left. Very often the fault too is in the pattern of the desk, and to this point further allusion will be made. Of congenital scoliosis I have seen three examples. It is probably due either to intra-uterine rickets, or to malposition *in utero*. Rickety scoliosis comes on very often between the first and second years. The dorsal curve is generally to the right, and the prognosis is not at all good. The lateral curvature which arises from sciatica is distinctly rare. Sometimes the convexity of the lumbar curve is directed to the affected side and sometimes away from it. Static scoliosis, or scoliosis arising from asymmetry of the two halves of the body, is undoubtedly the most frequent form of all, and no opinion should be given upon a case of lateral curvature until careful measurements of both upper and lower extremities have been taken. The habitual position of the head should be observed, and it is often advisable to have the child's eyes examined for astigmatism. Empyema is undoubtedly a cause of very intractable lateral curvature, and the worst forms are seen after Estlander's operation.

There can be no doubt that adenoids and nasal obstruction are factors in the production of lateral curvature, and the sequence of events is as follows:—A contracted chest, and then antero-posterior curvature of the spine, with undue flexion. With this is associated feeble muscular development on account of the insufficient aeration of the blood, and then the spine is just in that condition that a slight determining cause will make it sag to one side or the other.

Symptoms and Course.—The symptoms and course of the disease fall into periods:—

(*a*) The incipient period or stage of onset. (*b*) The stage of development. (*c*) The stage of arrest. (*d*) The stage of improvement, or, as too often occurs, the stage of bony fixation of the deformity.

(*a*) The Incipient Period is but slightly marked, and little or no notice is taken of symptoms at that time. Pain is as a rule absent, although a feeling of weariness in the back may be complained of. A careful examination of the figure, which, however, is very seldom made, reveals slight elevation of one shoulder, some asymmetry of the flanks, projection of one hip, or a faulty habit of standing or sitting.

(*b*) The Stage of Development.—In healthy children there is little or no pain, but in weakly girls the amount of pain varies considerably, and it is interesting to observe that the most frequent site of pain is usually just below the scapula, on the convex side of the curve. There is also in nervous patients a good deal of diffused pain. When the deformity is considerable and of old standing, much pain is caused by the contact of the depressed ribs with the iliac crest and consequent irritation of the lateral branches of the last dorsal and upper three lumbar nerves. The other symptoms complained of during the stage of development are referable to alterations in the position of the viscera. It is interesting to note that there are certain ages at which increase in scoliosis often occurs. If untreated it will increase spontaneously up to the age of twenty-five, and again about forty and in old age. The majority of cases may be regarded as having attained the maximum of deformity at twenty-five. But in a small proportion of cases, as the result of debility, especially that which occurs from frequent child-bearing, a recrudescence occurs between the ages of twenty-five and forty; and in a smaller number of cases, owing to the failure of general health, a scoliosis which has been quiescent for thirty or more years will commence to increase, and cases have been recorded in which such took place as late as the sixtieth year.

(*c*) The Stage of Arrest.—This may be reached spontaneously, or as the result of treatment, and may occur either in slight or well-marked cases. And the possibility of natural arrest should always be borne in mind, for it shows that scoliosis is not always so serious a matter as it is sometimes said to be. The other class of cases in which natural arrest occurs is of quite a different aspect. The scoliosis is extreme, and it has ceased to increase simply because bony ankylosis has taken place, with ossification of the ligaments.

(*d*) The Stage of Improvement.—This never occurs spontaneously, but is only the result of properly directed treatment. It is recognised by observing the gradual diminution of all the signs of the deformity, especially the projection of the ribs on the convex side, and the acquisition of symmetry of the flanks. If, however, the patient has never been placed under treatment, and the deformity is progressive, then the final stage is reached of ankylosis of the spine, with ossification of the ligaments.

Morbid Anatomy and Pathogenesis.—Scoliosis is not a disease, but is an alteration in the position, shape, and texture of the spinal structures, dependent on long-continued pressure and twisting in abnormal directions. In extreme cases the bodies of the vertebræ become wedge-shaped towards the side of the convexity, and in this change of shape the intervertebral discs partake. The bodies also become more dense on the concave side, and osteophytes may be seen on the edges of the articulating surfaces. As the result of torsion the fronts of the bodies show oblique and spiral striations or ridges. The spinal canal is altered in shape, and is found to be irregularly oval. Considerable changes occur in the laminæ and processes. The spinous processes are deviated and directed to the side of the concavity; while the laminæ, pedicles, articular and transverse processes, all undergo some atrophy. The anterior spinal ligament becomes displaced, and appears to slip to the concave side of the curve. Ultimately it may undergo ossification. The spinal muscles undergo considerable degeneration from disuse, and fatty and fibroid changes occur in old-standing cases with convex curves only. There have been many explanations advanced as to the actual causation of lateral curvature, and these are all set forth in the various text-books, and therefore need not be repeated. Judson of New York, and Bradford and Lovett of Boston, have conducted several experiments on the cadaver, which throw a great light upon the origin of scoliosis; and to quote the last-mentioned authors, "the effects of the weight of the thorax, head, and shoulders would, if applied in a vertical direction, be to bend the spinal column forward and backward." But in flexible spines the superincumbent weight rarely falls directly; and their experiments show that when pressure falls obliquely, rotation of the vertebræ takes place, and is more marked than lateral flexion. But the greater the antero-posterior curvature of the spine the greater is the rotation, and the greater is the lateral flexion. Hence in flexible spines scoliosis or rotatory curvature follows. This is at first a physiological process, but it subsequently becomes, by the alteration in the shape of the bones and altered pressure, a pathological change. The order of events is weakening of the spinal ligaments and muscles occurring in a patient whose equilibrium is not perfect, and this is followed by antero-posterior flexion, rotation of the spinal column, and lateral flexion.

Prognosis.—A common idea prevails that the

patient, if left to herself, will "grow out" of it, but experience shows that such cases grow into it rather than out of it. Errors in prognosis are common. The first is, that the deformity is of the most serious nature; and the second is, that it is a trivial affection and will be outgrown. It may be briefly said that rickety scoliosis, beginning early as it does, and persisting all through the years of growth, is apt to do badly, and so do cases in which there is an hereditary history, and those following empyema and pleurisy and infantile paralysis. The later the age at which the deformity commences the better the prognosis, for the nearer is the age at which spontaneous arrest may occur. If the bodily health is well maintained the prognosis is better. Patients with long, narrow, and yielding spines, who grow rapidly, are generally bad subjects, and curvatures high up in the spine are troublesome to treat on account of the difficulty of giving efficient support. To persist in an unsuitable occupation naturally makes the prognosis unfavourable.

Prevention and Treatment.—The essentials of treatment of scoliosis are—(*a*) To prevent the deformity if threatened; (*b*) To correct it when present; (*c*) To maintain the correction.

(*a*) *Prevention.*—Careful attention should be paid to measures for improvement of the general health and nutrition. Weakly and town-bred children should be sent away into the country, and general loss of tone calls for massage, the use of the tepid bath in the morning, moderate exercise, and simple and sufficient diet. Children suffering from rickets or adenoids must be at once placed under treatment. All faulty positions should be corrected, and suitable chairs and seats ordered. The chief points in determining the suitability of chairs and desks may be thus enumerated:—The back of the chair should be at an angle of 120°, and shaped so that it fits the lumbar and dorsal curves, and supports the whole spine. If the child be round-shouldered the back of the chair should be carried up sufficiently high to support the head and cervical curve. The seat should be of the same depth as the child's thighs, or a little less, and about the length of his legs from the ground, and sloped backwards at an angle of 10°. The distance from the top of the seat to the top of the desk or table should be one-eighth of the height of a girl and one-seventh that of a boy. To all school desks a comfortable foot-rest inclined at an angle of 20° should be added.

The various means of treatment for the correction of the deformity and the maintenance of that correction are as follows:—1. Treatment of a general nature directed to the restoration of the general health. 2. Recumbency, to relieve the distorted spine of the superincumbent weight. 3. Postural methods which teach the patient the assumption of correct attitudes. 4. Exercises so planned as to increase the strength of the weaker muscles, and at the same time to bring into action to a less degree the normal ones. With the exercises massage can be advantageously joined. 5. Methodical correction of the curves by manipulation by the combined efforts of the patient and surgeon. 6. Artificial aids to the maintenance of the erect position. But it should be noted at once that such aids should be avoided as much as possible, and the more physiological methods tried.

There is no doubt that those cases are in a minority where any one of the above means of treatment is alone applicable, and the keynote of successful treatment lies in a judicious combination of the measures enumerated, due care being taken to see that all predisposing causes are eliminated. We will speak of these various measures in order.

Recumbency can only be employed to a limited extent, and most cases will not require more than one to three hours daily. It may be carried out either in the supine or prone position, or in the lateral position with a firm pillow placed beneath the ribs on the convex side. A Wolff's suspensory cradle is useful for carrying out lateral decubitus. In slighter cases partial recumbency for two to four hours daily is sufficient, and Ward's reclining-chair, adaptable to any angle, is of great value. Postural methods:—All faulty sitting and standing should be corrected, and regular drilling for half an hour daily may be resorted to. Patients who habitually stand at ease should have any shortening of one leg compensated by a cork sole. In cases of primary lumbar curvature Volkmann's oblique seat is very useful. Exercises are of the greatest value, and of all forms the manipulations designated *Swedish* are the best, and with the exercises massage of the weakly muscles is extremely valuable. In addition it is also important to develop the chest as much as possible by singing exercises. Dumbbells and Indian clubs are spoken highly of by some writers, but they are often unnecessarily heavy. Treatment by suspension from two parallel horizontal bars is also useful, except in cases where the spinal muscles are weak. When these bars are used, the hand on the concave side of the spine should be placed on the higher bar. Or a single bar may be swung obliquely, and then the hand on the concave side is placed on the higher part of it. Methodical correction by manipulation is useful, and it is carried out as follows:—The patient lies prone on the couch with the arms fully extended, and the couch is tilted slightly at the head. The attendant then presses on the convex ribs in a direction forwards and to the opposite side in such a way as to press all the prominent ribs in succession with the object of diminishing their projection,

and so lessening the rotation of the vertebræ. Of the various supports it is not necessary to speak fully. Suffice it to say that they find their place in those cases in which the deformity is so advanced that there is little hope of remedying it, but of preventing it getting worse. Little children with rickety curvatures are best placed recumbent and carried about in the wicker tray designed by William Adams.

The daily routine for a scoliotic patient in whom the deformity is fairly well marked but is not fixed, and shows signs of lessening on suspension, should be as follows:—A tepid bath in the morning, with friction of the back. After breakfast manipulation and drill and manual correction for about twenty minutes to half an hour, followed by rest for half an hour; then massage for about fifteen minutes, succeeded by recumbency and outdoor exercise. In the afternoon recumbency for one or two hours, and if the patient is strong enough to bear it exercises again for fifteen minutes. When the muscles remain persistently weak a light pair of spinal stays may be called for; the patient feels fatigue in attempting to hold herself erect. These, however, should be dispensed with as soon as possible. Attempts have been made to reduce lateral curvature by the forcible method, but they have not been followed by such a portion of success as to commend themselves to general approbation. Finally, it will happen that, in spite of all the methods indicated, certain cases, especially those of paralytic curvature, will get steadily worse, and one is obliged then to employ such supports as poroplastic jackets.

Spinal Caries or Angular Deformity

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Definition.—A morbid process occurring in the vertebræ, usually accompanied by absorption of bone, and resulting in deformity.

Synonyms.—Angular curvature of the spine; Pott's disease of the spine.

Etiology and Causation.—Spinal caries occurs generally during the years of active growth, and especially in early childhood. It frequently follows exanthemata. From 40 to 60 per cent of cases are met with between the first and the fifth years, and then up to the age of twenty-five years its incidence rapidly diminishes, but it is occasionally seen in middle life and even in old age. It is seen as frequently in girls as in boys. There is no doubt that the actual cause is deposit of tubercle in the vertebral column, either with or without a history of traumatism; but the injury to the back is the determining cause of the deposit of tubercle in that region. The writer is sceptical as to the existence of purely traumatic Pott's disease in the light of present knowledge.

Pathological Anatomy.—The region most frequently involved is the dorsal, particularly from the eighth to the twelfth dorsal vertebræ, while the cervical and lumbar regions are less frequently affected. The part of the vertebræ first attacked is undoubtedly the bodies, owing to the influence of the superincumbent weight of the body and their cancellous structure. In childhood each vertebra has an epiphysial plate on its upper and lower surface, and here the disease frequently commences as a tubercular juxta-epiphysitis. Thence it spreads to the intervertebral disc on one side, and to the body on the other. Occasionally the first sign of caries is seen at the anterior aspect between the anterior common ligament, or the disease may commence in the centre of the body or at its lateral or posterior aspect. Again it may originate by several foci in different vertebræ. Rarely it begins in the costo-vertebral articulations or in the transverse processes. The disease is a carious process, and the lesion is always accompanied by the formation of tubercular granulation tissue, and one of the following events may happen: (*a*) The granulation tissue is absorbed as fast as it is formed, the bone disappearing gradually without the formation of pus (caries sicca), but resulting often in considerable deformity. (*b*) The granulation tissue breaks down, and abscess forms. (*c*) In rapid cases portions of bone of considerable size may be isolated by rarefaction and form sequestra, always a serious event owing to the persistent suppuration which ensues. (*d*) If the area involved is a small one, calcareous degeneration of granulation tissue takes place, and an encysted nodule forms, which remains harmless for years. (*e*) In some cases ossification occurs in the inflammatory material, and ankylosis of the affected vertebræ follows.

The ligaments, especially the anterior common ligament, become softened and thickened, while the periosteum on the surfaces of the neighbouring vertebræ becomes inflamed, and occasionally spiculæ of bone are thrown out which may subsequently serve as supports to the new tissue formed across the chasm at the site of disease. The immediate result of destruction of one or more vertebral bodies is angular deformity, and it is the appearance of this which occasionally leads patients to seek advice. As a rule, the deformity is antero-posterior; but in rapid cases combined with

this there is lateral deviation of the spine; and this is doubtless due to destruction proceeding more rapidly on one side of the vertebral bodies than on the other. It is important to recognise lateral deviation, as it has been mistaken for scoliosis, just in the same way as scoliosis with projecting vertebræ has been taken for Pott's disease. When considerable erosion of the bodies has ensued, the features of the lateral deviation are merged into and lost in those of the general deformity of the column.

The extent of erosion and actual destruction of the bodies varies widely. It may be so slight that little or no deformity is produced, or it may be so severe that the upper part of the spine will be found at a right angle to the lower. True dislocation rarely occurs, but merely a bending forwards of the spine at the site of disease, and with this the spinal canal is often widened, although the space for the spinal cord is limited by the presence of granulation tissue, so that compression-paraplegia results.

Antero-posterior deformity of old standing may be recognised by the following characteristics: The projection is rounded, and has a bursa of considerable size and density over its most prominent points. In advanced cases—especially in the dorsal region—the shoulders are elevated and droop forward, the sternum is prominent, the ribs are compressed from side to side, the scapula raised, the neck shortened, and the head is thrown forwards and the chin is unduly prominent. Alterations in the position of the viscera take place, and the writer has seen the apex beat of the heart in the third intercostal space in the nipple line. Hilton Fagge drew attention to the kinking of the anterior wall of the thoracic aorta (*see* Fig. 1), and with it there was associated hypertrophy of the heart. The lungs become compressed, and the abdominal viscera are pushed downwards.

It is essential to keep a record of the deformity from time to time, and this is best effected by taking an outline of the projection with a strip of sheet lead, and then marking the outline of the curve so obtained on cardboard, and cutting it out to the pattern so drawn. An increase in the degree of curvature may occur under two conditions: Firstly, when the destructive process is going on quickly in the bodies; and, secondly, when active disease has ceased and healing is taking place, the bodies settle down. And then a further development of the posterior projection may follow, unless the spine is properly supported.

Symptoms.—The history is not as a rule very trustworthy, but careful inquiry should be made as to the presence of tuberculosis in the family. Pain is present in the majority of cases, and a characteristic of the pain of spinal caries is that it is felt not so much over the site of the disease itself as at a distance—that is to say, it is *reflected* pain. This is the reverse of what obtains in so-called hysterical spine and railway spine, and it is important to remember this generalisation. Reflected pain assumes the form of headache or shooting pains in the arms in cervical disease; of sternal pain or neuralgia in the side in dorsal disease; of stomach-ache or girdle pain in dorso-lumbar, and of growing pains in the lumbar form of the affection. It is liable to increase on sudden movements, and occasionally night-starts occur.

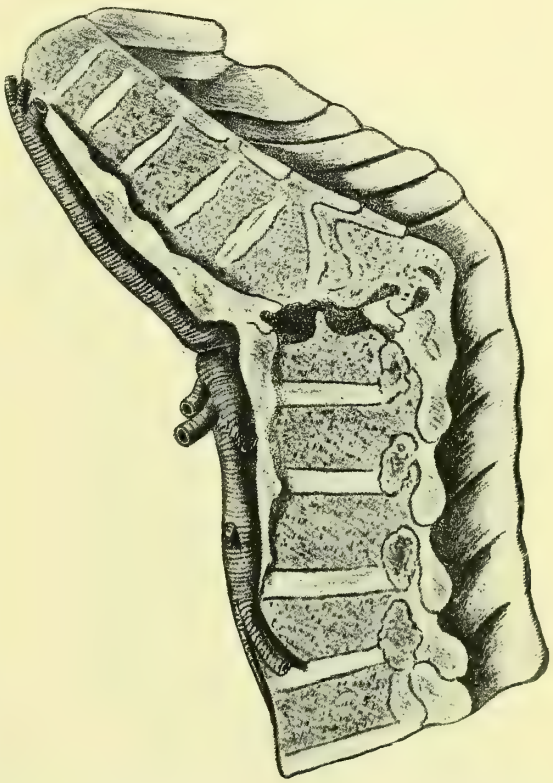


FIG. 1.—Kinking of the aorta in spinal caries. "Section of the spine showing extensive caries of the vertebræ with angular deformity. The last four dorsal vertebræ are greatly diseased, the two middle are nearly destroyed, and the portions of the upper and lower have fallen together. The other dorsal vertebræ are also affected on their anterior surfaces." (Guy's Hospital Museum, 1290.)

Pain may be elicited sometimes by pressure over the spinous processes, and movements of flexion and extension and rotation will also be painful. The method of jarring the spine by sudden pressure on the vertex in the erect position is a cruel and unnecessary test. A sudden increase of pain is often symptomatic of onset of abscess, increase of the deformity, or the commencement of paralysis. But when treatment is effectual the first result is gradual decrease and finally loss of the pain. The general symptoms are those of loss of flesh and malaise, want of appetite, slightly raised temperature in the evening, and in addition cough. Dyspnœa and gastric disorders may be

met with at the onset of the disease. Dilatation or constriction of the pupil has been observed both by Charcot and Gowers in cervical caries.

The Signs of Spinal Caries.—The earliest and the most important of all is rigidity, in the first place, of the muscles on either side of the affected area, and later of the vertebræ affected. Muscular rigidity can be determined by palpation, and rigidity of the affected vertebræ can be detected by directing the patient to flex and extend the spine. The affected vertebræ will then be felt to move *en bloc*, and not in succession. In more advanced cases the rigidity is demonstrated by inviting the child to pick up a small article from the floor.

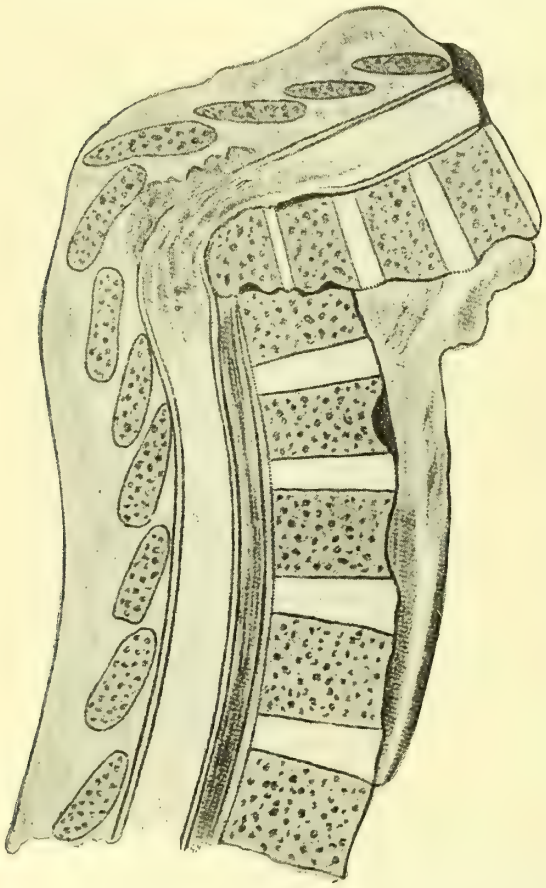


FIG. 2.—Caries of the spine. Compression of the cord partly by displaced bone and partly by granulation tissue. (Guy's Hospital Museum.)

In disease of the lower cervical or upper dorsal region there is short, grunting, spasmodic respiration due to the attempt to keep the chest and spine as rigid as possible and so to avoid pain. In early cases, in suspected disease of the dorsal and lumbar region, the extensibility of the spine may be tested by laying the patient on his face, and then gently lifting the feet from the couch and noting the amount of extension in the lumbar part of the column. The attitude and walk of a child afflicted with caries—whether it be in the cervical, dorsal, or lumbar region—is perfectly characteristic. The attitude may be summed up as a *military attitude*, or, as Professor Sayre says, "the child places himself in a muscular splint."

As the disease progresses there will be irregularity of the spinous processes or projection of one or more of them, with alteration of the normal curvature. Thus the cervical curve will become flat or convex posteriorly, the dorsal region will very early show posterior projection, and the lumbar region will first become flat and then somewhat convex. Thickening will be felt around the affected vertebræ when the disease has been well established; and in the grave stages of caries, if the palm of the surgeon's hand be gently and firmly pressed over the posterior projection, the bones will be felt to yield unduly. But as repair and healing takes place, yielding is replaced by a distinct resistance. *To sum up* the symptoms, rigidity must be regarded as the first and most important symptom—the patrol of disease. Note the patient's aspect and walk on entering the room, observe the attitude he assumes at rest, trace pains to their sources, search for any irregularity of the vertebræ, place little reliance on the history, and be on the look-out for abscess and paralysis.

Diagnosis.—There is probably no disease in which so many mistakes are made as in early spinal caries, and errors can only be avoided by very careful examination. Thus any child who complains of pain in the stomach should have his back looked at, and the examination be repeated from time to time. In infancy and early childhood rickety kyphosis is not uncommon, but the presence of other signs of rickets, the general yielding of every part of the back, the distribution of the curve over the whole back, its disappearance on suspension or lying down, the extreme extensibility of the spine, and the absence of localised pain are sufficient points of distinction. In young adult life, especially in girls and young women, in neurotic boys, and in men after railway accidents we find the hysterical or neuromimetic spine. In such cases the pain is patchy, it does not follow the course of nerves, but it is limited to certain local areas with more than one point of special intensity, and it may also frequently change its seat. Unsuspected watching of the case and carefully repeated examination of the back are necessary. Yet there is great danger that caries of the spine in a young woman may be put down as hysterical. Still more if the subjects of caries present distinct signs of hysteria there is a risk that unequivocal signs of caries may be overlooked.

The diagnosis between angular deformity and lateral curvature is quite easy as a rule: the only confusion arising in those cases in which caries is associated with lateral deviation of the

spine or scoliosis is associated with prominent vertebræ. But it should be observed that in caries with lateral deviation there is no prominence of the ribs, and the distortion is not a sinuous curvature, but it seems as if the upper part of the spine were slipping off the lower. In cervical caries confusion may arise between it and wry-neck. But in wry-neck the movements are free in every direction, save when the contracted muscle is pulled upon; whereas in caries movement is limited in every direction. The writer has known dorsal disease to be mistaken for pleurisy and for perinephritis and perityphlitis, and lumbar disease to be mistaken for hip disease or sacro-iliac disease.

Prognosis of Uncomplicated Caries.—In uncomplicated caries it may be said that the prognosis depends upon the following factors: the stage at which the disease is diagnosed—of course the earlier the better; the social surroundings of the patient; and the surgical care and nursing which he can obtain. In these events the outlook is by no means very serious, and many patients recover entirely, and become vigorous men and women. But far different is it for the children of the poor, who are often unfortunately unable to command all these attentions. Too often the disease assumes a retrograde form, and abscess or general tubercle follows. The actual percentage of recoveries is difficult to estimate, since the cases must be watched through so long a period. But Neidert investigated 31 cases, and the average age at the time of death was forty-nine and a half years.

Treatment.—In spite of the severe nature of the disease, cure may often be effected, especially if the case comes under skilled observation in its earlier stages, and deformity may and should be prevented. The method of cure is by ankylosis, and when the disease is treated early and thoroughly, and the number of vertebræ affected is small, the patient recovers with a very useful back. The treatment may extend over years, and the writer is disposed to think that its duration is often shorter than is required, and for want of continued supervision many cases relapse.

The general treatment is comprised in fresh air, sunshine, regular and plentiful food.

Local Treatment.—The principles are three in number: (*a*) To keep the spine as still as possible, and to place it under the best circumstances for healing; (*b*) to remove the weight of the upper part of the body from the diseased vertebræ; (*c*) to prevent the occurrence of deformity, and if deformity has occurred, to endeavour to decrease it. To carry out these principles we have two methods at our disposal: recumbency (and with this may be combined methods of gradually extending the spine, if there be deformity), and the use of retentive apparatus.

The *indications* for recumbency are as follows: in all acute cases, when on employing the palm-pressure test to the back it is found to yield anteriorly, also when abscess and paralysis are threatened, and particularly in cases of severe cervical and lower lumbar caries. In children recumbency may be resorted to with less danger to the general health than in adults. The immediate effects are good, the pain disappears, the nervous irritability is lost, the face loses its anxious aspect, and the patient puts on flesh. The disadvantages of recumbency can be combated by keeping the patient in the fresh air. It is difficult to speak of the duration of recumbency, and each case must be judged on its merits. But it may be said that when the patient becomes restless, moves his arms and legs freely, and attempts to turn over, and can do so without pain, then the time has arrived for the child to sit up with proper supports. The objects of simple recumbency have been stated, but the removal of intra-vertebral pressure is desired also, and this can be accomplished by arching the back forwards at the site of disease. A very efficient apparatus is the gas-pipe frame, which was originally designed by Schapps of New York, and has been improved by Bradford and Lovett.[1] If the spine is placed in the extended position, there is no necessity to apply weight extension either to the head or to the feet. But in little children it is necessary to prevent movement, and for this purpose a Fisher's bed frame answers admirably. Phelps of New York has designed a special box arrangement for cases of spinal caries in the poorer classes, but although useful for carrying them about, it is by no means sightly.

When the surgeon is satisfied that the severer symptoms have subsided, the spine is firm, and the possibility of abscess or other complications is slight, it is well to adopt a combination of the methods of partial recumbency and fixation appliances. All complicated arrangements are to be avoided as much as possible; in the plaster of Paris jacket properly applied, to some extent in the poroplastic jacket, and in a Taylor's brace of the latest model, most of the needful requirements are fulfilled. Briefly, these are that every apparatus must firmly fix the site of disease, that all weight must be taken off the the affected region by transference of pressure from diseased to healthy parts; the apparatus must be comfortable, cleanly, and removable, and pressure on the skin and chafing must be avoided. If the apparatus is inexpensive and can be readily applied by the surgeon, the greater is its merit. Taking a case of dorsal caries, there are three fixation points: the pelvis, the site of disease behind, and the depression in front between the chest and the shoulder-joint. And from the latter points the forward

[1] *Orthopædic Surgery*, 2nd edition, p. 42.

push of the upper part of the body can be restrained.

An important question is, When may treatment be dispensed with in spinal caries? The absence of pain is no test, since pain naturally ceases if a support be worn. But if pain ensues on the removal of the support, the jacket must be put on again. Then if the deformity has remained stationary for a year or two, the support may gradually be dispensed with under careful supervision. But in all cases it should be remembered that if the curvature be at or immediately above the eighth dorsal vertebra, axillary crutches and shoulder-straps should be used, and if it be above the fifth dorsal vertebra, a head support must be added to the spinal one.

The Complications of Spinal Caries.—The most important are abscess, compression-paraplegia, and deformity.

Spinal Abscess.—The tendency to the formation of abscess is greater the lower in the spine the disease occurs. And, roughly, it may be said that in out-patient practice about one case in ten develops an abscess. But the earlier the treatment is begun, and the more efficiently it is carried out, the less liable are abscesses to form. Yet it must not be assumed that the occurrence of abscess is evidence of incomplete treatment, for in many cases an abscess cannot be avoided. In the cervical region when an abscess forms, the direction the pus takes depends very largely upon the relation of the suppurative focus to the deep cervical fascia. Thus pus may pass directly forwards, and form a post-pharyngeal abscess with its dangerous train of symptoms, or it may pass laterally and appear at the anterior margin of the trapezius, or directly backwards and appear on either side of the vertebræ. Sometimes, however, it tracks downwards, enters the posterior mediastinum, and opens through an intercostal space posteriorly. Pus formed in the dorsal region, if it comes from the upper or mid dorsal spine, appears as a dorsal abscess following the course of the posterior branches of the intercostal arteries. If pus arises in the lower dorsal vertebræ, it passes beneath the ligamentum arcuatum internum and forms a psoas abscess. If it arise in the dorso-lumbar and lumbar region, it may give rise to either a psoas, lumbar, iliac, or pelvic abscess, and its course is dependent upon the relation of the suppurative focus to the attachments of the lumbar fascia. The contents of the abscess vary; sometimes they are serous, or sero-purulent fluid with caseous masses. In old-standing cases the contents are cheesy, and in almost all cases fragments of carious and necrotic bone are found. The future course of an abscess is variable, but the great point is to prevent it bursting spontaneously and without antiseptic precautions, because the abscess track may become septic and persistent suppuration ensue. The question of spontaneous absorption arises, and there is no doubt that some of these abscesses become smaller in size, but this is due to absorption of the more fluid contents of the abscess sac, leaving behind a residuum of cheesy or calcareous material, in which numerous tubercle bacilli can occasionally be detected.

Treatment.—The methods of treating spinal abscess are many, and they are the following: —The expectant, by aspiration, incision and drainage, incision and cleansing of the cavity and sewing up. The method which the writer has pursued for the last five years in the treatment of these cases is as follows:—All cases of spinal abscess should be placed at rest and carefully watched, and sometimes it happens that the abscess spontaneously diminishes in size, and it is better to let it alone. But if it steadily increases in size, it is well to wait until it comes to a point easily accessible to treatment. Take, for example, a psoas abscess which appears above and below Poupart's ligament. When the abscess is approaching the subcutaneous tissues it should be opened in at least three or four places—one incision, if possible, being in the lumbar region, one in the iliac region, and one below Poupart's ligament. The contents are then evacuated, and the abscess sac is thoroughly washed out with sterilised water, and cleansed and dried with sterilised sponges. Either iodoform emulsion, or better still, a solution composed as follows: Menthol ʒj. dissolved in ℥j. of alcohol, and then added to one pint of glycerine and well mixed, should be injected, and the sides of the abscess cavity well rubbed with it. The excess of the menthol solution is then removed, all the apertures immediately stitched up, pressure pads placed along the course of the abscess cavity, and firm bandages applied. Very often the abscess heals by primary union, but occasionally it happens that a little fluid collects beneath one of the incisions, and can be evacuated aseptically later. When the child is kept at rest no further trouble ensues from the abscess if the case be merely one of caries. But if necrosis is going on in the vertebræ, a re-collection of pus must be looked for, which must be treated on the same lines.

Compression-paraplegia.—It occurs sooner or later in about one in eight cases of spinal disease, but fortunately is by no means a prominent complication in most instances. It is not due, except in rare instances, to direct pressure of bone on the spinal cord, but it arises from the presence of granulation tissue in the spinal canal, or is due to the formation of intraspinal abscess; or—as the writer believes—the most frequent cause is the thickening of the membranes, a tubercular pachymeningitis. With reference to pressure on the cord by pus, it is a very true observation that abscess and compression-paraplegia are very seldom associated, and further, that if an abscess makes its appearance the nerve symptoms subside. Unfortunately,

when paralysis has existed for some time ascending and descending degenerations set in. The paralysis is usually bilateral. It affects the legs generally, although the arms may suffer later, or both may be paralysed. Its onset is, as a rule, gradual, occasionally sudden, and Sir William Gowers mentions the case[1] of a child aged three, a sufferer from disease of the cervical vertebræ, who lost the power of moving the legs in the course of twenty-four hours. During the second day the left arm became paralysed, and at the end of a week the right arm.

The effect of the peripachymeningitis on the spinal cord itself is as follows:—It suffers slow compression and becomes much narrowed, even to the size of a goose quill or less, and then it undergoes myelitic softening, which is followed by increase of the neuroglia, sclerosis, and ascending and descending degeneration. At the same time the nerve roots suffer from pressure and exudation of new material round them.

Symptoms of Compression-paraplegia.—These necessarily vary with the site of disease. The onset is in some cases very sudden, and is due then either to displaced bone, rupture of a blood-vessel, acute myelitis, or tubercular meningitis. As an instance of acute onset another case of Sir William Gowers may be quoted: "A woman, aged forty-five, who had suffered from pain in the spine, one day sneezed violently three times, and immediately felt 'pins and needles' in the right knee and foot. The right leg became powerless during the next three days, the left leg followed suit, and at the end of six weeks both legs were motionless. She died six months later." The symptoms may be best arranged, not in the order of their onset, but from a functional point of view.

(*a*) Motor.—The patient complains of being tired easily, and the legs begin to drag and the toes to catch in walking. Then follow loss of equilibrium and inability to move the lower extremities. If the disease is in the cervical region, the arms suffer before the legs.

(*b*) Sensory.—The most usual sign of onset is a girdle pain due to irritation of the nerve roots. Oftentimes there is no anæsthesia, for sensation is at times present when motion is lost. Anæsthesia dolorosa in patches is not uncommon.

(*c*) Reflexes.—The superficial ones are exaggerated, and so too are the deep, especially of the knee and ankle, but when degeneration has set in they are lost.

(*d*) The Sphincters.—Incontinence of urine and fæces occur in severe cases.

(*e*) Trophic.—The affected muscles waste, and reaction of degeneration is more or less marked. Before wasting occurs, distinct spasm of muscle is found, notably if the disease is in the dorsal region. Acute bed-sores are not uncommon.

[1] *Diseases of Nervous System*, 2nd edition, vol. i. p. 347.

(*f*) Vaso-motor.—The limbs are often cold, and sometimes perspire persistently.

(*g*) Special to Various Regions.—In the cervical region the pupil may be dilated or contracted, and sweating of one-half of the forehead may be marked. In the dorsal region the intercostal muscles are affected; and in the lumbar region the knee and ankle reflexes are lost.

Prognosis.—A very large proportion of these cases recover under treatment by recumbency and without operation. The number is said to vary between 55 and 83 per cent, and some cases have had four attacks and many three attacks with a good recovery.

Treatment.—The treatment is of two kinds, conservative and operative. The expectant or conservative plan of treatment is undoubtedly the best, and its prognosis is exceedingly good. It necessitates complete rest in bed, with extension of the spine, by weights applied to the legs and counter-extension of the shoulders and the neck, or by the use of the convex couch of Bradford and Lovett, or by means of a suspension couch; and the time needed for recovery varies from a few weeks to fifteen to eighteen months. Bed-sores should be carefully guarded against.

Treatment by operation is either by forcible extension of the spine or by laminectomy. Of 31 cases in which paralysis was present, 17 were relieved by forcible extension, 4 were partially relieved, 2 were unrelieved, and no statement was made as to the paralysis in 8 cases. But, unfortunately, there is no information as to whether any attempts to relieve paralysis by this method were fatal. If prolonged treatment by recumbency and by forcible extension fail, then it is necessary to consider the propriety of laminectomy. The statistics of this operation are not very reliable, because it is not distinctly stated in how many cases the treatment by recumbency had been tried. And knowing the great probability of cases recovering spontaneously in that way, it is justifiable to surmise that some of the laminectomy cases would have recovered without the operation. This remark, however, can only be applicable to the minority of recorded cases. Laminectomy, however, can only be considered as a remote hope. The risks of the operation are very considerable. Of 75 cases collected by Lloyd 29 died, and in 58 surviving cases there were 20 recoveries, 7 were improved, and in 8 no good result followed. So that the prognosis of the operation, both as to the possible cure of the disease and as to life, is by no means good, and it is not applicable to those cases where symptoms of extensive degeneration of the cord are found.

Deformity. — Deformity may be called a complication of spinal caries, and is by no means a necessary result of the disease. If cases are recognised and treated from the first, it is not too much to say that little or no deformity

should appear. But, unfortunately, such an ideal result is not always possible. The amount of deformity varies from a slight projection of a spinous process to a prominence implicating the greater part of the dorsal and lumbar region. The amount of deformity depends upon the degree of destruction in the vertebral bodies. It also has a direct relation to the thoroughness of the treatment. By insisting upon early and sufficient recumbency with the spine in a fully extended position healing will often take place in a most satisfactory manner. The only difficulty is to maintain this corrected position by suitable supports, the usual errors being that the supports are neither firm enough nor carried sufficiently high.

Rectification of the deformity, or forcible correction of the spine, has been revived by Chipault of Paris, and largely practised by Calot of Berck-sur-Mer. Chipault wired the spinous processes together, a method which was first described by Hadra. Contrary to anticipation, forcible correction of the spine is not attended with so much risk as is supposed, and rectification has been successful in relieving patients of paraplegia. Accidents have been recorded, such as rupture of abscesses, rupture of the pleura, and the onset of acute tuberculosis. In a paper which Messrs. Jones and Tubby read at the Clinical Society in 1901,[1] of 99 cases which had been watched for over three years, the number of deaths was not greater than that ordinarily occurring in Pott's disease; while the number of cases of paraplegia cured contrasted very favourably with the results obtained by laminectomy. Bradford and Lovett have collected together 610 cases recorded by twenty-nine operators. Twenty-one deaths were reported, but no case showed effectual effort at repair in the sense of bridging over the gap, one being examined two and a half years subsequently to correction. Thirty-one cases had paralysis previously, and 17 were relieved. The effect on the deformity was as follows:—Of 229 cases where this point is stated, complete correction was obtained in 119, incomplete in 94, and no gain occurred in 16. The result three months later was as follows:—In 66 cases there was no relapse in 17, some relapse in 44, and total relapse in 5.

While the operation is an easy one, and often requiring very little force, and while the immediate results are so satisfactory, the greatest difficulty is experienced in maintaining the correction, and no one should undertake a case who is not prepared to see it at least once a month and watch it keenly for several years. In many cases no anæsthetic is required, and it is astonishing with what ease an apparently firm projection yields to manual pressure when the patient is fully extended. Goldthwait of Boston employs a special frame with a mechanical contrivance for gradually exerting pressure, and so reducing the deformity. An important point is that not too much should be attempted at one sitting, and it is better to do a little at a time, leaving intervals of at least a month between. A judicious selection of cases is a matter of the greatest importance, and the following should be excluded:—Those presenting a very large degree of old-standing deformity where it is evident that ankylosis has taken place. Adults are not favourable subjects for the treatment, nor should it be attempted if abscess be present, on account of the danger of rupturing the abscess wall. If active tubercle exist elsewhere, operative treatment of this kind is precluded. Cervical and high dorsal cases do not give satisfactory results. On the other hand, favourable cases are those occurring in children and adolescents where the curvature is not of very great size and is recent; where no signs of tubercle are present elsewhere, the general health is fair, and the child can be adequately supervised for a long period afterwards. Other things being equal, compression-paraplegia not yielding to recumbency is a distinct indication.

[1] See *Clin. Soc. Trans.* 1900.

Other Affections of the Spine.

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Lordosis is an exaggeration of the normal lumbar curve. It is found normally in women of some races—and in almost all cases where the abdomen is distended by fat, ascitic fluid, tumours, or pregnancy. Lordosis of paralytic origin is associated with pseudo-hypertrophic paralysis, progressive muscular atrophy, and occasionally acute anterior poliomyelitis. A compensation lordosis is met with in congenital hip displacement, in acquired hip disease, and in coxa vara. It is also found in children the subjects of rickets, because the heavy, pendulous abdomen requires a certain counteracting force in the spine to maintain the upright position. Spondylolisthesis also produces a condition of lordosis. And there is a class of cases occurring in infants in which the head is retracted and the posterior cervical muscles are rigid. Such cases are often mistaken for meningitis, but they are reflex and due to injudicious feeding. The treatment of lordosis depends upon the cause.

Kyphosis, not due to caries, may be classified as follows:—(1) Kyphosis of infancy, due to feeble muscular development and rickets; (2) Kyphosis of childhood, due to rickets, acute anterior poliomyelitis, pseudo-hypertrophic muscular paralysis, hereditary hump-back; and it is also met in association with chest deformities arising from adenoids and nasal obstruction; (3) Kyphosis of adolescence, or round shoulders; (4) Kyphosis of adult life, due to (*a*) occupation, *e.g.* in cobblers, tailors, and porters, (*b*) muscular and gonorrhœal rheumatism, (*c*) arthritis deformans, (*d*) osteitis deformans, (*e*) osteomalacia, (*f*) progressive muscular atrophy, and (*g*) bronchitis and emphysema. It will therefore be seen that the causes are very diverse. In infants and very young children rickets causes so much weakness that they are unable to sit upright. When the case is very severe, and the back almost powerless, the child should be nursed as much as possible in a reclining position, or carried about in a padded wicker tray. For older children who sit up, but with a bent back, a backboard of leather with axillary and perineal straps attached is very useful. Of course the diagnosis from spinal caries should be carefully made. In childhood, if the posterior curvature persist, the best treatment is a combination of recumbency, douching and shampooing, active and passive exercises of the muscles, and a support. It should be remembered that persistent antero-posterior bowing of the spine in children is often a prelude to scoliosis later. Therefore it is essential to remove all possible causes, especially adenoids and nasal obstructions. Round shoulders are frequently the result of a so-called weak spine due to too rapid growth, chronic illness, or general debility, and the groups of muscles which are particularly affected are the trapezii and the serrati magni. Flat foot often coexists with this condition. The treatment consists in removing the causes, improving the general health, strengthening the enfeebled muscles, and in correcting the existing deformity. One of the most potent causes is faulty positions at school and in piano practice, and, no doubt, the length of lessons is much to be deprecated. To correct any deformity the chief reliance must be placed on gymnastic exercises. Artificial supports in the majority of cases are faulty in theory and pernicious in practice. The object of the exercises should be expansion of the chest, straightening of the back, and an erect carriage of the head.

In old age kyphosis is due to general wasting of the tissues, and absorption of the intervertebral discs, particularly in the dorsal region.

Osteomalacia.—The forward bending of the spine, which may be very extensive, is due to softening of the bones and ligaments. Unfortunately little or nothing can be done for it.

Osteitis Deformans (Paget's Disease). — Kyphosis is one of the characteristic symptoms of this disease, and the spine becomes prominent, particularly in the cervical and upper dorsal regions, and the head falls forward on to the chest. The spine is rigid and painful. Osteitis deformans has been shown to be a chronic inflammatory disease affecting the bones of the cranium, of the spine and pelvis, and the long bones, and it is eventually fatal.

Spondylitis Deformans is also called rheumatism of the spine, or rheumatoid arthritis of the spine. Some cases present a similar condition to that in arthritis deformans. But it seems that in cases of spondylitis deformans the spine is first affected, while in arthritis deformans the joints of the extremities first suffer. Spondylitis deformans occurs in children occasionally, but most frequently in young male adults, and is often preceded by a history of gonorrhœa. The pathological changes are very similar to those produced by arthritis deformans, with the addition of ossification of the spinal ligaments, and intervertebral substances and fusion of the vertebræ. A certain group of these cases, one of which was described by Pasteur in 1889, shows implication of the muscles and soft parts, and scleroderma is associated with the condition. The symptoms are as follows: constant pain, occasionally becoming acute, gradual loss of movement in the back, exaggeration of the dorsal curve, and flattening of the lumbar curve. The disease appears first of all in the lower dorsal and lumbar region, and gradually spreads to the cervical area until the whole spine is rigid. It then affects the costo-vertebral articulations, so that the movement of the ribs is lost in respiration. After a time stiffening of the shoulders occurs. The disease is of an extremely chronic nature, and treatment seems to have little or no effect. Pain may be mitigated by hot fomentations or by electricity and massage, but active and passive movements are to be avoided, and they are often harmful.

Spondylolisthesis.—The definition of this term is a slipping forward of the body of one of the lumbar vertebræ from the bone immediately below it. We say the *body* advisedly, because the laminæ and spinous processes remain practically in place. The usual vertebra affected is the fifth lumbar, sometimes the fourth, and slipping of the first sacral vertebra has occurred in one recorded case. The displacement varies in degree, and the intervertebral discs may be obliterated or replaced by an arthrodial joint. The pedicles of the affected vertebra may elongate, or the arch is completely separated from the body. Neugebauer gives the following causes: separation of the vertebral arch due to congenital defect or to fracture, disease of the sacro-vertebral articulation, and bony changes the result of pressure. It occurs most frequently in women, and at puberty or shortly afterwards, and many of them say that they

have had a severe accident. Some cases seem to be associated with pregnancy. The symptoms are lessening of the obliquity of the pelvis, combined with lordosis, and Neugebauer states that these are characteristic signs. A vaginal examination reveals a bony prominence and the lessening of the conjugate diameter. As the neural arch is not displaced there is no irregularity in the outline of the spinous processes. Occasionally symptoms arising from bony pressure on the viscera occur. The treatment consists in supporting the lumbar spine until reunion of the affected vertebræ has taken place.

Acute Osteomyelitis of the Spine.—This is a similar condition to that which affects the long bones, and it is directly due to the streptococcus and staphylococcus pyogenes aureus following an injury or secondary to suppuration elsewhere. It is particularly prone to affect adolescents at the time of most rapid growth.

The symptoms are those generally due to osteomyelitis and the local signs of acute inflammation of the vertebræ. Subsequently pus forms, and paralysis is said to have been present in one-third of the recorded cases. The mortality is very high, and the only treatment is evacuation of the pus when possible and supporting the spine.

Typhoid Spine.—Gibney of New York has described an inflammation of the perivertebral structures, accompanied by excessive pain and stiffness coming on after typhoid fever, and the writer has himself seen two interesting cases—one in a child of six, and one in a young woman of seventeen. The symptoms are excessive pain and stiffness of the back, but the prognosis is good.

Syphilitic Disease in the Spinal Column.—The balance of clinical evidence seems to show that syphilis affects the spinal column in the form either of caries or gummatous deposits. And in the cervical region, which is most frequently affected, the disease appears to originate in a specific ulceration of the pharynx. Such a case is recorded, and a specimen is figured by Hilton.[1] Other instances are quoted by Howard Marsh, and Reeves mentions a case of syphilitic caries in a boy who coughed up portions of his vertebræ which had penetrated the lung. Fournier's classical case of syphilitic disease of the lumbar spine is quoted by Barker.[2] The diagnosis is difficult, and rests largely upon the history of infection, the presence of specific deposits elsewhere, and the results of anti-syphilitic treatment. But in spite of these tests it is difficult to exclude tubercle as a contributory or exciting cause of the disease in the vertebræ, and records of post-mortem examinations are peculiarly wanting.

[1] *Rest and Pain*, p. 111.

[2] Holmes, *System of Surgery*, 2nd edition, vol. ii. p. 421.

Malignant Disease of the Spine.—The forms of malignant new growth are sarcoma and carcinoma. These are rarely primary, but are commonly secondary to neoplasms elsewhere. The disease begins by a deposit of malignant cells in the vertebral bodies, and the bone is gradually replaced by the diseased soft tissue, so that deformity results. Occurring as it does most usually in the lumbar vertebræ, the deformity is less than it would be in the dorsal vertebræ, and if pain is absent—as occasionally happens—the disease is not recognised during life. But in by far the majority of cases the pain is so extreme and agonising, and is referred so constantly to the back, that this in itself is diagnostic. Paralysis due to pressure on the spinal nerves often complicates the case.

Hysterical Spine.—The diagnosis of this condition is very difficult, and we must remember that many cases are thought to be hysterical which by subsequent history are proved to be due to distinct disease. Before a patient is said to have hysterical spine a careful examination should be made. It frequently follows a minor injury, such as occurs in slight railway accidents. The pain is most acute over certain vertebræ, unlike the pain in Pott's disease, which is rarely severe over the diseased vertebræ, but is mainly felt at the periphery. The pain is subacute, increased by fatigue, and there are local areas of hyperæsthesia. The more attention is given to the back the greater the pain, and some patients hold their backs very stiffly while being observed, but when off their guard they will move their backs with freedom. But it should be noted that there is no deformity, and even if hysterical paraplegia supervenes the absence of a localised posterior projection will be a point in favour of hysteria, since it is rare for paraplegia to occur without some deformity in Pott's disease, although it is not quite unknown. The treatment consists in improving the general health, careful feeding, massage, and exercises to strengthen the spinal muscles.

Lumbar Puncture

Lumbar puncture, or puncture of the spinal canal, was introduced by Quincke in 1891 for the relief of excessive intracranial pressure in hydrocephalus, and has since been extensively used both for purposes of diagnosis and treatment. The method of performing it is as follows: the skin of the patient over the lumbar spine and its neighbourhood is thoroughly sterilised, and a sterilised trocar is introduced 5 to 10 millimetres on one side of the middle line between the third and fourth lumbar vertebræ, and passed for 2 centimetres in children, and from 4 to 6 centimetres in adults, slightly inwards. In elderly subjects the point is directed upwards as well as inwards, until the point of the trocar is felt to be in the subarachnoid

space. An excellent summary of the procedure is given by Hand.[1] The physical and chemical examination of the cerebro-spinal fluid and pathological examination of the same have yielded fair results, but it may be stated at once, while positive evidence is of value, negative results are far from conclusive. It has been shown that fibrin always forms in meningitis when the fluid is allowed to stand, but it is absent in cerebral abscess. Blood is due to the puncture of a vessel, but it also has its origin in injuries to the head or spine, sub-dural hæmorrhages, or hæmorrhage into the ventricles. If the fluid be turbid, it is said to be an indication of infective meningitis. In tubercular meningitis the fluid may be almost clear. The normal amount of glucose is 4-5 centigrammes per 100, and this is increased in pneumonia, but is absent in the later stages of tubercular meningitis, and that variety caused by Weichselbaum's meningococcus or Fraenkel's diplococcus. In tubercular meningitis and some cases of cerebral tumour and hæmorrhage the normal amount of albumin is increased. In 1898 Stadelmann stated that in tubercular meningitis tubercle bacilli were only found in 22 per cent of the cases. In suppurative meningitis the fluid is turbid or purulent, and contains meningococci, pneumococci, staphylococci, and streptococci. But occasionally in undoubted cases of meningitis complicating middle ear disease a clear fluid with no bacteria is found. Typhoid bacilli have been found in two cases, and the bacillus coli communis has also been demonstrated.

From a therapeutic point of view lumbar puncture has been disappointing. It does not relieve the symptoms of hydrocephalus nor of tubercular meningitis. Some temporary improvement may follow the withdrawal of a small quantity of fluid in suppurative meningitis, but in cerebral tumour there is no doubt the procedure acts unfavourably. Some punctures have been followed by sudden death. In apoplexy, hæmorrhage, pachymeningitis, cerebral hæmorrhage, and embolism puncture is dangerous. Some transient success has followed its use in uræmia, lead poisoning, and in paraplegia.

Spinal Cocainisation to produce Surgical Analgesia

It seems that Dr. Korning of New York first employed this method, although the credit has been given to Bier of Kiel, and it has been largely advocated by Tuffier of Paris.

The method of injection is as follows: the skin, the Pravaz syringe, and the needle having been very carefully sterilised, the operation may be painlessly performed by injecting some Schleich's analgesic fluid beneath the skin. The needle is then introduced at the following point, the patient being seated. A transverse line is drawn between the posterior superior iliac spines, a point taken slightly to one side of the midpoint of this line, and the spinal canal is entered. After making sure that the needle is in the subarachnoid space, by observing that a few drops of cerebro-spinal fluid can be withdrawn, the injection is made.

A 2 per cent solution of cocaine is used, and 15 to 25 minims injected. If, however, 5 minims of a 2 per cent solution of cocaine be mixed with 25 minims of a 4 per cent solution of antipyrin, it is found to be quite sufficient for an extensive hæmorrhoid operation by the cautery on a vigorous man, according to G. R. Fowler. Tuffier is the great advocate for the production of analgesia by this method, and has performed 252 major operations with it, many of which were severe abdominal ones. But he notes very unpleasant symptoms in some cases afterwards, and deaths have been reported, though not in his practice. Generally, its disadvantages may be said to be as follows:—

The injection of cocaine into the lumbar region does not produce analgesia above the diaphragm. The possibility of septic complications following the puncture and injection must be considered. It is much more toxic in its effects than chloroform or ether, and is probably more fatal than ether. It often fails to produce the required degree of anæsthesia, and causes much delay. And the patient, being conscious, realises what is being done to him. Finally, the procedure does not appear to have any advantages over the methods of general anæsthesia, and there is not sufficient evidence that its employment is justifiable.

Caisson Disease

Syn.—*Compressed Air Disease; Diver's Paralysis*

A disease produced by immersion in an atmosphere of compressed air. The clinical features involve mainly the nervous system, and comprise pain in the limbs, and paraplegia, with or without loss of control over the sphincters. The symptoms may develop immediately on leaving the caisson, or may be postponed for some hours after coming out. The pain develops suddenly and may be paroxysmal in character, and may be accompanied by some abdominal pain and vomiting. There are usually no local physical signs, but in some cases the legs are tender to the touch. Auditory vertigo with slight deafness and tinnitus is present in a few cases, and sometimes these symptoms are present alone. Epistaxis is occasionally met with, and in some cases the patient may lose consciousness, and the case simulates apoplexy.

The etiology of this disease is not fully determined. Numerous theories have been

[1] *American Journal of Medical Sciences*, October 1900.

advanced from time to time: that most worthy of attention was formulated by Paul Bert, who suggested that the symptoms depended on the increased solution of gases by the blood during the sojourn in compressed air, and on their escape during "decompression" (Snell).

Post-mortem examination of a few cases has revealed foci of hæmorrhages, softening and laceration of the cord.

The Treatment.—Mainly preventive. Careful regulation of the degrees of the pressure, and attention to the purity of the compressed air in the caisson, are essential. Care should be taken to ensure that the passage through the lock from the high to the ordinary pressure should not be accomplished too rapidly. Plethoric subjects are naturally more subject to this disease, and special care should be taken with regard to them.

Most cases make a good recovery. Paraplegia and other severe manifestations must be treated on general medical principles. Morphia may be indicated if the pains are severe. If the patient is seen soon after the commencement of the illness, Snell says that "recompression" generally allays the symptoms in a marvellous way, and this improvement may be maintained if the recompression be followed by a very slow exit of, say, half or three-quarters of an hour. Auditory complications are not, as a rule, amenable to treatment.

Spinthariscope.—An instrument for showing the peculiar physical properties of radium (Gr. *σπινθήρ*, a spark, *σκοπεῖν*, to see); it was devised by Sir William Crookes, and it consists of a small brass tube fitted with magnifying lenses at one end and closed at the other, having a piece of paper coated with crystals of zinc sulphide at the blind end, and having a metal pointer which has been dipped in a solution of a salt of radium placed in front of the zinc sulphide paper; when one looks into the spinthariscope in a dark room a continuous shower of sparks is seen to be passing from the pointer. *See* Radium.

Spintherism.—The sensation of sparks dancing before the eyes; synchisis scintillans (Gr. *σπινθήρ*, a spark).

Spiral.—Winding or curved like a screw; *e.g.* a spiral bandage, a spiral duct, spiral fibres, a spiral groove, the spiral lamina (in the internal ear), or a spiral line.

Spirals, Curschmann's. *See* Curschmann's Spirals.

Spirem.—The "mother skein" of chromatin fibrils in a cell undergoing karyokinesis or mitotic division (Gr. *σπεῖρα*, a twist). *See* Physiology, Cell (*Reproduction of Cells, Mitosis*).

Spirillum.—A micro-organism or bacterium having a spiral form, *e.g.* the spirillum Obermeieri (the organism of relapsing fever) and the spirochæte pallida (of syphilis). *Spirillosis* is the name given to any affection due to spirilla, and especially to a disease of fowls characterised by diarrhœa, loss of appetite, and convulsions. *See* Micro-Organisms (*Bacteria*); Relapsing Fever (*Synonyms*); Teeth (*Bacteriology of Mouth*).

Spirit or Spiritus.—In Pharmacy *simple spirits* (spiritus) are solutions in alcohol of a volatile oil such as cinnamon, juniper, or peppermint, or of camphor, chloroform, or ether; there are also complex spirits, prepared by distillation, including *spiritus ætheris nitrosi*, *spiritus ammoniæ fetidus*, etc. *See* Alcohol.

Spiritus Rectificatus.—Rectified spirit, containing 90 per cent by volume of ethyl hydroxide and 10 per cent of water. *See* Alcohol (*Spirits*).

Spiritus Vini Gallici.—Brandy or cognac, containing not less than 43½ per cent by volume of ethylic alcohol.

Spiro-.—In compound words *spiro-* (Gr. *σπεῖρα*, a twist) means spiral; *e.g. spiro-bacteria*, *spiromonas* (a biflagellate monad), and *spirophore* (an instrument used in artificial respiration).

Spirochæte.—A spirillum or spiral bacterium, such as the spirillum Obermeieri of relapsing fever and the spirochæte pallida of syphilis (*vide* Syphilis). *See* Micro-Organisms (*Bacteria*); Relapsing Fever (*Bacteriology*); Syphilis; Teeth (*Bacteriology of Mouth*).

Spirometer.—An instrument for measuring the respiratory capacity of the lungs. *See* Physiology, Respiration (*Amount of Air Respired*); Respiration (*Mechanism*).

Spital.—Hospital, *e.g.* spital-house.

Spitting. *See* Expectoration; Fluids, Examination of Pathological; Lung, Tuberculosis of (*Clinical Features*); Lungs, Gangrene (*Symptoms*); etc.

Spitzka's Bundle.—A tract of nerve fibres of the cerebrum which passes from the cortex of one side to the oculomotor nuclei of the other side through the pyramidal region of the crus cerebri.

Splanchnic.—Relating to the viscera (Gr. *σπλάγχνον*, the inward parts or the bowels). *See* Intestines, Diseases of (*Anatomical Considerations*).

Splanchno-.—In compound words *splanchno-* (Gr. *σπλάγχνον*, the bowels) means relating to the intestines or to the interior of

the body; *e.g. splanchnology* (visceral anatomy), *splanchnoskeleton* (the part of the skeleton related to the viscera), etc.

Splanchnopleure.—The visceral or inner layer of the mesoderm in association with the entoderm. *See* Embryology; Fœtus and Ovum, Development of (*Segmentation of Ovum*).

Splanchnoptosis. *See* Enteroptosis and *Cross References.*

Splayfoot. *See* Deformities (*Flat-Foot*).

Spleen.

The Surgery of the Spleen

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See Abdomen, Injuries of (*Lesions of the Spleen*); Abdominal Tumours, Diagnosis of (*The Spleen*); Anæmia, Pernicious (*Pathology*); Anthrax; Children, Clinical Examination of (*Abdomen, Spleen*); Hæmatemesis (*True, Splenic Anæmia*); Heart, Myocardium and Endocardium (*Effects of Cardiac Disease, Cyanotic Spleen, and Embolism of the Spleen*); Hydatid Disease (*Echinococci of the Spleen*); Kidney, Surgical Affections of (*Movable and Floating Kidney, Diagnosis*); Kidney, Surgical Affections of (*Hydronephrosis*); Kidney, Surgical Affections of (*Tumours, Diagnosis*); Lardaceous Degeneration (*Diagnosis, Waxy Spleen*); Leprosy (*Clinical Features*); Leucocythæmia (*Symptoms*); Leucocytosis (*Leucopenia*); Liver, Diseases of (*Portal Cirrhosis, Spleen*); Liver, Tropical Diseases of (*Portal Thrombosis*); Malaria (*Sequelæ, Splenic Enlargement*); Mumps (*Complications, Splenic Enlargement*); Ovaries, Diseases of the (*Ovarian Tumours, Diagnosis*); Physiology, Blood and Lymph (*Fate of the Blood Constituents, Hæmolysis*); Ponos; Post-mortem Methods (*Examination of the Body Cavities, Spleen*); Spleen, Medical Affections; Syphilis (*Visceral, Liver and Spleen*); Syphilis (*In Children, Viscera*); Tuberculosis (*Morbid Anatomy, Spleen*); Typhoid Fever (*Complications, Splenic Infarctions*).

Our knowledge of the functions of the spleen is very uncertain; observation as well as experiment indicate that, whatever these functions may be, they are shared by other organs. The spleen is not a vital organ; this is proved by the fact that many men and women have survived its removal, and an examination of such individuals does not reveal anything that would enable one to suspect that they are spleenless.

The appalling immediate results of indiscriminate splenectomy, especially when the operation was performed for leukæmia, threatened to exclude excision of the spleen from the sphere of legitimate surgery, but the excellent results which have followed a careful and judicious selection of cases since 1890, serve to show that the operative risks are not greater than those of ovariotomy.

The spleen has been removed for a variety of diseases, such as leukæmia, amyloid spleen, malarial spleen, syphilitic enlargement, echinococcus cysts and colonies, sarcoma, and also when it has been torn (ruptured) and when displaced (wandering spleen).

It is clear from this list that splenectomy has been performed for a variety of diseases, and a perusal of the list indicates that the majority of the diseases which lead to enlargement of the spleen are secondary to, or form part of, other morbid processes, and it is easy to comprehend the uselessness of removing the spleen under such conditions. A critical analysis of the collected records of splenectomy indicates that it can only be expected to succeed in the following conditions:—(1) Rupture of the spleen; (2) Wandering spleen; (3) Splenomegaly; (4) Abscess; (5) Echinococcus cysts; (6) Malarial spleen.

Rupture of the Spleen.—In the majority of instances rupture of the spleen is a rapidly fatal accident; death in some cases has been as speedy as when an aneurysm of the aorta bursts. Injury to the spleen may arise in a variety of ways, *e.g.* kicks from horses and from men; falls upon angular objects or ridges; falls on the belly when drunk, and even when sober; crushes between carts, carriages, or locomotives; blow from a cricket-ball, stabs in warfare and civil broils, and bullet-wounds. When the spleen is injured by the passage of a vehicle or any severe crush, it is often complicated by fracture of the neighbouring ribs. When the spleen is enlarged in malaria it is especially liable to rupture even from slight causes, such as straining induced by vomiting or coughing. It is a fact that injury to an enlarged spleen is not, as a rule, followed by such free bleeding as ensues on injury to a normal spleen. This is illustrated by a remarkable case recorded by Vincent. He performed cœliotomy on a woman, expecting to remove a large ovarian tumour, but found a large black mass instead. During the manipulation his hand broke into it; there was free bleeding, and the mass was recognised as a large malarial spleen. The hole in the spleen was stuffed with gauze; for a long time a sinus persisted and discharged black material. It eventually closed, and a year later nearly the whole of the spleen had disappeared. The woman was in good health.

The signs of injury to the spleen are those common to severe internal bleeding: they include what is called shock attended by pallor,

dilated pupils, faintness, coldness of the skin, and rapid failure of the pulse. In very exceptional instances, when a very large quantity of blood escapes into the belly, it may give rise to a shifting dulness on percussion. The amount of blood which is lost varies in different cases. Should the tear in the spleen involve the artery or the vein, rapidly fatal hæmorrhage will be the consequence, but wound of the spleen in any part causes free bleeding. Undoubted cases have been recorded in which patients have recovered from rupture of the spleen. Thus in one case in which a man had his spleen ruptured, and recovered; three weeks later he was murdered, and at the autopsy the recent cicatrix was clearly seen in his spleen.

The treatment of rupture of the spleen, in order to be successful, should be prompt. In cases where the lesion is so grave as to demand quick intervention, there is generally such damage to the organ that the only way to effectively and expeditiously arrest the bleeding is to ligature the gastro-splenic omentum with the splenic vessels and remove the spleen. Under such conditions it is, as a rule, a simple proceeding.

Wandering (Movable) Spleen.—It is difficult to conceive that a viscus like the spleen suspended by peritoneum to the under surface of the diaphragm, connected to the stomach by means of the gastro-splenic omentum, and by its blood-vessels brought into such intimate bondage with the pancreas, could so elongate its attachments as to reach the uterus and the floor of the pelvis. In well-marked examples a movable spleen is capable of such free excursions that it may be brought in contact with every part of the abdomen and pelvis. No adequate cause for such abnormal mobility of the spleen has been suggested; it is, however, a significant fact that the majority of cases occur in women, and especially those who have been pregnant.

Undue mobility of the spleen leads to its engorgement, and as the structure of the organ is favourable for the retention of a large amount of blood, it is obvious that it would be more liable to over-distension when pendulous at the end of a long stalk formed by the elongated splenic vessels and the gastro-splenic omentum. This engorgement becomes intensified when the pendulous spleen spins on its axis and twists its pedicle; in this condition the spleen looks so replete with blood as if ready to burst. When a wandering spleen undergoes axial rotation, it gives rise to much the same symptoms as an acute strangulated hernia or an ovarian cyst with a twisted pedicle. When the rotation is so acute as to completely arrest the circulation in the spleen and persists, it will lead to permanent occlusion of the splenic artery and vein, and atrophy of the spleen.

A wandering spleen often produces inconvenient effects on adjacent viscera. In the case of the pancreas, it sometimes happens that this gland remains undisturbed even when the spleen falls into the pelvis; in other instances the pancreas becomes elongated and has been stretched to a length of 25 cm., forming part of a twisted pedicle making three turns around the splenic artery. Occasionally the tail of the pancreas will be dragged down to the brim of the pelvis by a mobile spleen. A wandering spleen will so pull upon the stomach as to kink the duodenum and lead to dilatation of the stomach with its usual consequences, fermentation of the food and vomiting; the tension may even cause obstruction to the common bile-duct and produce jaundice.

It can easily be imagined that the long cord-like pedicle of a pendulous spleen would be very liable to interfere with the intestines, and cases have been observed in which movable spleens have been found adherent to small intestine, colon, and the vermiform appendix. Adhesions of this character not only set up intestinal obstruction, but they lead to damage of the bowel, which allows of the escape of the contents and micro-organisms, and thus initiate septic peritonitis.

Mention has already been made of the great tendency of a wandering spleen to drop into the pelvis, and its weight not only causes retroflexion of the uterus but has been known to produce prolapse of this organ (Kouwer).

Wandering spleens not only cause grave inconvenience, but they seriously jeopardise life. The actual dangers are: rupture of the stomach or duodenum, intestinal obstruction, abscess of the spleen, rupture of the spleen.

A movable and enlarged spleen has been mistaken for a variety of conditions, such as uterine fibroids, ovarian cysts, renal tumours, and movable kidneys. In several cases cœliotomy has been performed for the purpose of removing a uterine or ovarian tumour, and a displaced spleen found instead. Varneck records a case in which he removed a tumour adherent to the walls of the pelvis; he regarded it as a fibroid. When the tumour was examined in the laboratory it was proved to be a spleen! The chief signs on which a diagnosis may be based are the characteristic spleen-like shape of the swelling, the presence of notches on one of its borders, the peculiar way in which it seems to float on the intestines, its convex surface, and the facility with which it can be guided under the left costal arch.

The most effective treatment of a wandering spleen is removal. The risks, immediate and remote, are very slight. An alternative method (splenopexy) of stitching the spleen to the side has been suggested and even practised. So far the results of splenectomy are more satisfactory, and the convalescence is much more speedy.

Splenomegaly.—It has already been mentioned that enlargements of the spleen are re-

markable in that they are usually secondary or form part of other morbid processes: the condition which will be described under the term splenomegaly is probably the only form of persistent enlargement of the spleen which is not thus associated (*see* "Banti's Disease," p. 313). On studying splenectomy lists, here and there will be seen the term "splenic hypertrophy"; a critical examination of these cases indicates that the term is employed when the enlargement of the spleen cannot be ascribed to leukæmia, malaria, syphilis, amyloid disease, or tumours, or interference with the portal circulation. On microscopic examination all the normal elements of the organ are increased in corresponding proportion, and the trabeculæ are particularly obvious, but there are no features in the splenic tissue which enable us to determine the cause of its increased size.

The writer's experience is limited to two cases: a girl of five years and one of seventeen. In the last patient the spleen was removed because it dragged on the stomach and caused persistent jaundice. In the child the spleen was removed on account of its size: it was associated with anæmia. In both patients the operation was successful, and five years later they were in excellent health.

Echinococcus Cysts.—Many cases have been recorded in which echinococcus cysts and colonies have formed in the spleen. Large cysts are not common; the majority of the cases have been observed in the post-mortem room. In a few instances they have been successfully drained when their nature has been detected in the course of a cœliotomy. In rare instances they have been diagnosed before operation.

Abscess.—A primary abscess in the spleen is rare. The condition commonly called a splenic abscess is usually outside the spleen and associated with an injury to this organ, and is in reality a localised suppurative peritonitis, and often complicated with fracture of the overlying ribs.

The appropriate treatment is incision and free drainage. In some cases the surgeon may find it necessary to remove the spleen, and there are conditions in which the removal of this organ facilitates convalescence.

Malarial Spleen. — Enlargement of the spleen is a common consequence of malaria, and it is accompanied by an abundant deposit of characteristic black pigment. Spleens of this kind sometimes become very movable, and this fact as well as the increase in size renders them very liable to injury, and also causes them to be mistaken for ovarian cysts and uterine fibroids. Many malarial spleens, especially when "wandering," have been excised, and the operation has been attended with great success.

Obliteration of the Splenic Vein.—This is an extremely rare condition, but it is worth considering on account of the peculiar signs associated with it. The writer's experience is limited to one case. A nurse, twenty-six years of age, suffered for six years from recurring attacks of profuse hæmatemesis associated with a big spleen. The bleeding was attributed to a gastric ulcer, and the amount of blood she lost in some of the attacks was so great as to reduce the red corpuscles of blood to 662,000 per c.mm. Gradually the corpuscular elements would increase until they reached the proportion of 3,200,000 per c.mm. This always indicated that hæmatemesis was imminent and invariably happened within a few days. The woman herself knew when to expect an attack, and eventually died after a profuse bleeding.

At the *post-mortem* examination the splenic vein was large enough to admit the index finger; it contained pouched recesses, and at its junction with the superior mesenteric was blocked by an organised thrombus.

Tuberculosis of the Spleen.—In exceptional circumstances a tuberculous spleen may become so enlarged as to be a source of inconvenience and even of danger. Spleens enlarged in this way have been successfully removed.

Aneurysm of the Splenic Artery.—This is a very unusual condition. The aneurysm may burst into the stomach, the colon, or into the peritoneal cavity. It is a rare cause of sudden death.

Splenectomy.—The two great causes of death after removal of the spleen were hæmorrhage and septic peritonitis. The former cause of death has been abolished now that surgeons are particularly careful to exclude from operation any case of leukæmia; and peritonitis is prevented by the strict employment of aseptic measures in the performance of cœliotomy.

Some cases have been observed in which, after removal of the spleen, there has been noticed an enlargement of all the external lymph glands accompanied with anæmia, a quick pulse, and elevated temperature. These changes have supervened within a few weeks of the operation. In most of the cases they have gradually subsided; and it is worthy of note that in nearly all the instances in which these remarkable changes followed, the spleens were removed from healthy individuals on account of injury.

Spleenless individuals enjoy good health. The writer has seven patients under his observation from whom he removed the spleen for various conditions, and there is nothing to indicate that they have lost the spleen (vide *Trans. Clinical Society*, London, vol. xxxiv.).

Medical Affections of the Spleen

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Physiology.—Very little that is definite is known about the normal functions of the spleen. It is certainly not necessary to life or to health, and it has long been known that it can be removed safely. It is a contractile organ, its movements being due to the unstriped muscle in the capsule and trabeculæ. Rhythmic movements of contraction and dilatation take place at intervals of about a minute, in dogs and cats at least, and there is also a slow expansion after meals, which reaches its highest point about the fifth hour and is then followed by a slow contraction.

Much attention has been directed to the relationship of the spleen to blood-corpuscles. Red corpuscles are undoubtedly formed in the spleen during fœtal life, but this function is definitely transferred to the bone-marrow at or soon after birth in man and in almost all mammals, and is only temporarily restored to the spleen, if at all, under conditions which profoundly modify the whole blood-forming functions. The relation of the spleen to destruction of red corpuscles is still *sub judice*. There is no difference in the number or character of the red corpuscles in the blood going to the spleen and in that coming from it, while removal of the spleen has no influence on the number of the blood-corpuscles nor on the proteids of the blood-plasma, and after hæmorrhage or hæmolysis the normal number of red corpuscles is regained as rapidly in splenectomised animals as in those whose spleens are intact. As regards white corpuscles, there seem to be rather fewer in the splenic vein than in the splenic artery, and the lymphocytes which are certainly formed in the Malpighian corpuscles do not seem to be supplied to the blood in any large numbers, at least the proportion of them in the splenic vein is not noticeably increased. Further, with regard to the possibility of internal secretion, the injection of splenic extract has been shown not to be followed by the increase in the number of red corpuscles which is produced by the injection of extract of red marrow, and is indeed apparently without influence on the blood.

Pathology. — The great majority of the pathological conditions affecting the spleen give evidence in the same direction as what is known of its physiology, namely, that its *rôle* is very largely a passive one, and that it acts as a reservoir for blood, especially for the portal system. Most of these changes in the spleen are therefore secondary to other diseases, and are described under the appropriate headings, or in the accompanying section of the surgery of the spleen.

General Diseases affecting Spleen. — Of the *general diseases* which cause change, usually enlargement, in the spleen, there may be mentioned leucocythæmia, malaria, enteric, typhus, and other fevers, septicæmia, waxy disease, relapsing fever, syphilis, etc.

Liver Changes affecting Spleen.—A second series of splenic enlargements are associated with *changes in the liver*. The most frequent of these is cirrhosis, where splenic enlargement is almost constant; other affections are pylephlebitis, acute and suppurative or chronic, and all conditions such as tumours, gummata, peritoneal thickening, which exercise pressure on the portal vein, or its branches in the liver, or on the splenic vein itself.

Circulatory Changes affecting Spleen.—Acting in more roundabout fashion, but as effective, are the whole series of *cardiac diseases*, valvular or myocardial, where compensation is imperfect, and even aneurysms and obstructive lung lesions may have the same effect. Enlargement of the spleen is much less likely to ensue in all this series in children and in old people than in those in middle life.

Pulsating Splenic Tumour.—A very curious though rare condition is the *pulsating splenic tumour*. This requires for its production the combination of cardiac disease and an acute splenic enlargement due to an infective fever. The cardiac condition is generally aortic regurgitation, or sometimes hypertrophy of the left ventricle without valvular disease, and in all the cases observed compensation has been good. The fevers causing the acute enlargement may be enteric, malaria, or croupous pneumonia.

Tumours.—Primary tumours of the spleen are exceedingly rare, and even secondary metastases are by no means common, certainly not so common as the anatomical arrangement and blood-supply of the organ would lead one to expect. Of primary tumours, fibromata, angiomata, lymphangiomata, dermoid cysts, and cysts (non-parasitic), uni- or multi-locular, and containing serous fluid or blood, have been described, and while the first four have usually only been discovered on the post-mortem table, the cysts have on several occasions been large enough to cause inconvenience and to require removal of the organ. Solitary hydatid cysts are rare. It is doubtful whether primary cancer of the spleen occurs; the reported cases have either not been examined microscopically or the description leaves much to be desired. It is difficult to believe that an epithelial growth could occur primarily in an organ so pre-eminently mesoblastic in origin unless from inclusion. Sarcoma of several varieties has occurred. The symptoms are fairly definite—first, splenic enlargement, then pain (usually severe) and tenderness, then rapid growth of the organ and the appearance of prominences on its surface. Metastases occur early, and removal of the spleen has not in these cases been followed by prolongation of the patient's life. Lymphosarcoma is better considered later.

So-called Primary Enlargements.—The fourth group of splenic enlargements includes many of

the apparently *primary enlargements* of the spleen, and these are usually associated with anæmia. The wildest confusion still reigns in this subject, and it is exceedingly difficult to harmonise the views of different observers. One cause of difficulty is the retention in text-books of descriptions of disease from the pre-hæmatological era; another is the fact that the cases are generally of rare occurrence, are often insufficiently reported, and that the nomenclature is often more a reflection of the fancy of the observer than of the facts of the case. Some outstanding groups can, however, be distinguished by fairly marked characters. These may be classed as (*a*) splenomegaly without anæmia; (*b*) splenomegaly with anæmia, with its sub-groups (1) Banti's disease, (2) splenic anæmia, (3) pseudoleukæmia, (4) lymphosarcoma; and (*c*) splenomegaly in children, of which the most important form is the anæmia pseudoleukæmica infantum.

Splenomegaly without anæmia (primary splenomegaly) is a very rare condition. Cases have recently been described by Bovaird and by Brill. Brill saw three cases in one family, and had two of them under observation for over fifteen years. The special points in the cases were a slow, progressive, causeless, and enormous enlargement of the spleen, with excellent health for years (a slight anæmia of chlorotic type developed after the disease had been established for more than ten years, and after an intercurrent affection), a normal leucocyte count and proportion, some enlargement of the liver, and a slight tendency to hæmorrhage. Some of the other cases similar to the above have also occurred in family groups. The cause is entirely unknown.

Splenomegaly with Anæmia.—(1) *Banti's Disease.*—This is in reality a cirrhosis of the liver, associated with a marked enlargement of the spleen which clinically entirely overshadows the condition of the liver. Jaundice may or may not be present, and the disease may last for several years. Anæmia is always marked, the red corpuscles are greatly reduced in number, the colour-index is low, nucleated reds are frequent, white corpuscles are almost always diminished in number, and the lymphocyte proportion is high.

(2) *Splenic Anæmia* and (3) *Splenic Pseudoleukæmia.*—These are often indistinguishable, and probably cases which are clinically similar are often due to dissimilar pathological processes. The most typical cases of "splenic anæmia" are very rare, and show, besides the enlargement of the spleen, a marked anæmia with diminution both of red corpuscles and hæmoglobin, sometimes with slight leucocytosis, and often with a rather high lymphocyte proportion. The disease is remittent, periods of severe anæmia and increase in the size of the spleen alternating with long periods of health with normal or nearly normal blood and with diminution but not disappearance of the enlarged spleen. It is probable that the late stages or the acuter forms of the condition which I have described as splenomegaly without anæmia have also been regarded as splenic anæmia, and some of the recorded cases are distressingly like subacute or chronic cases of lymphatic leukæmia without a very high leucocyte count. One of West's cases, for instance, a month or so before death had 50,000 leucocytes per c.mm., "chiefly lymphocytes," and other cases are equally doubtful. Some cases of lymphadenoma or pseudoleukæmia have greatly enlarged spleens, either with enlarged lymphatic glands and liver or without; and these cases, which usually present a chronic progressive anæmia of chlorotic type, are often called splenic anæmia. The red cells in these cases do not fall very low in number, the hæmoglobin-index is usually low in the earlier and slighter cases, but may be higher in advanced or acuter cases. The anæmia never approaches the pernicious type, however. The leucocytes in chronic cases are normal or diminished in number, and there is a relative lymphocytosis. The more rapid and febrile cases show a leucocytosis with increase of polymorphs. The pathology of the condition is involved in the same obscurity as that of the lymphatic gland form (*see* "LYMPHADENOMA"), and it is certain that the same clinical features may be associated with tubercle and with gumma of the spleen as with the less definite conditions which pass under the name of lymphadenoma.

(4) *Lymphosarcoma.*—This form of sarcoma may take rise from any collection of lymphoid tissue in the body. The diagnosis is rarely uncertain when it occurs in such a situation as the tonsil, as there a circumscribed tumour forms in which ulceration soon takes place; but when it occurs in the lymphatic glands the diagnosis is more difficult, and most difficult of all when it arises from the spleen. As it tends to spread at the point of origin a large spleen is soon produced, and as the metastatic growth takes place along lymph-channels, the affected glands are concealed by their depth in the abdomen and thorax, and abdominal masses which might otherwise be discovered are hidden by the spleen. The rapidity of growth of the splenic tumour varies considerably; sometimes it is so slow that the clinical picture is that of pseudoleukæmia, sometimes as rapid as with the more malignant varieties of sarcoma. The examination of the blood may give some hint of the state of the case, however, for the lymphocytes, which, in most of the cases already discussed, are actually or proportionally increased in number, sometimes show a very marked diminution. In a case of Reinbach's, for instance—a lymphosarcoma of the neck, it is true—the lymphocytes, whose normal proportion is about

25 per cent, sank to 0·6 per cent. In splenic cases so large a proportion of the lymph-tissue could not be prevented from supplying lymphocytes to the blood until a very late stage of the disease, but the diminution may well be considerable. In many cases, however, it will be impossible to make the diagnosis during life.

Splenomegaly in Children.—In the first years of life blood differs from that of adults in several respects. The proportion of lymphocytes is higher, say 40 per cent instead of 25, leucocytosis is much more easily produced by chemotactic influences of all kinds, and in anæmia nucleated red corpuscles are very apt to appear in the blood—a reversion to the embryonic condition. These cells are usually normoblasts, but may be megaloblasts, which are of course normally present in the blood in early fœtal life. The spleen enlarges readily in all the chronic anæmias of infancy, no matter what their cause, and the proportion of red marrow in the bones is greater than in adults and is readily increased by such conditions as rickets. These facts make it often very difficult to determine to which variety of blood disease an anæmia belongs. Pernicious anæmia, and leucocythæmias of both varieties undoubtedly occur in children; but about twelve years ago von Jaksch attempted to differentiate another disease, which he called *anæmia pseudoleukæmica infantum*. Much has been written for and against this differentiation, but the most recent views are in favour of the acceptance of von Jaksch's distinction. The children affected are from six months to four years old as a rule, and most of them are rickety. Syphilis, intestinal catarrh, and chronic tuberculosis seem also to be causally associated with the disease. The children are pale and badly nourished, and the most striking feature is the enlargement of the spleen, and in a less degree of the liver; the lymph-glands may also be moderately enlarged. In the severer cases there is a tendency to hæmorrhage. The disease runs a chronic course, and may terminate in recovery after some months, or, on the other hand, may end fatally by anæmia and asthenia, by hæmorrhage, or by intercurrent affection. Pathologically, the enlargement of the spleen is a simple hyperplasia: the marrow is red and soft throughout, and contains an undue proportion of nucleated red cells. The liver has been described as containing islands of blood-forming cells, and if this observation is confirmed, it would give one the impression that the marrow was insufficient for the required blood-formation, and that it was passed back to the liver as well, which in fœtal life is a blood-forming organ. In the blood the red cells are greatly diminished in severe cases, exceptionally falling to a million. The ordinary corpuscular changes of severe secondary anæmia are found with a quite excessive proportion of nucleated red cells. The majority of these are normoblasts, but megaloblasts may occur. The colour-index is low, even in cases with megaloblasts, however. There is usually high leucocytosis — from 20,000 to 50,000— which persists without much change. Lymphocytes are always relatively increased, even beyond the normal high proportion in infants. Eosinophiles are usually at or about the high normal number of infants, say 5 or 6 per cent. Myelocytes are uniformly present, though not in such large proportion as in myelæmia. The essence of the disease seems to be a blood-destruction, probably from unknown toxic influences, but the liver does not contain the deposits of iron found in pernicious anæmia, nor is there any leukæmia infiltration of organs.

Treatment of Splenic Enlargements.—From all that has been said of the physiology and pathology of the organ, it will be seen that the vast majority of splenic conditions are secondary to disease elsewhere, and that the enlargement of the organ is to be regarded as a symptom, often a very valuable one from the point of view of diagnosis, but not calling as a rule for special interference except in those cases, dealt with elsewhere, where removal is advisable for surgical reasons. Since the discovery of the importance of the bone-marrow in blood-formation, the spleen has ceased to be credited with impossible and contradictory functions, and it is to be hoped that the knowledge that the changes in the marrow are also secondary to influences from other organs may lead us in time to the correct interpretation and scientific treatment of many of these perplexing anæmias.

Splenæmia. *See* LEUCOCYTHÆMIA.

Splenalgia.—Pain in the spleen, especially of a neuralgic type.

Splenculus. — An accessory spleen or lienculus.

Splenectomy.—Excision of the spleen. *See* SPLEEN, SURGERY OF (*Splenectomy*).

Splenic Fever. *See* ANTHRAX.

Splenin.—A therapeutic preparation made from the spleen.

Splenisation or Splenification. —Conversion of the tissue of an organ (*e.g.* the lung) into a thickened and infiltrated state resembling splenic tissue.

Splenitis.—Inflammation of the spleen. *See* SPLEEN.

Splenius. — Shaped like a *splenium* or bandage, and, hence, a name applied to a muscle so shaped (*splenius capitis*, *splenius colli*) and also to the posterior end of the corpus callosum (*the splenium*).

Spleno-. — In compound words *spleno-* (Gr. σπλήν, the spleen) means relating to the spleen; e.g. *splenocele* (hernia of the spleen), *splenodynia* (pain in the spleen), *splenomalacia* (splenic softening), *splenoptosis* (downward displacement of the spleen), and *splenorrhaphy* (suture of the spleen).

Splenomegaly. — Enlargement of the spleen (Gr. σπλήν, the spleen, and μέγας, large) which cannot be ascribed to leukæmia, malaria, syphilis, waxy disease, tumours, or interference with the portal circulation; when associated with anæmia and hepatic cirrhosis it is known as Banti's disease. *See* Spleen, Surgery of (*Splenomegaly*); Spleen, Medical Affections of (*Primary and Secondary Splenomegaly*).

Splenopexy.—The operation of fixation (by sutures) of a wandering spleen. *See* Spleen, Surgery of (*Wandering Spleen*).

Spleno-typhoid. — A variety of typhoid fever in which intestinal symptoms are absent and the spleen is the chief organ affected. *See* Typhoid Fever (*Symptoms*).

Splints. *See* Bed-Sores (*Splint Pressure-Sore*); Fractures (*Treatment*); Mouth, Injuries and Diseases of the Jaw (*Fracture of Mandible*); etc.

Split Pelvis. — A form of pelvic deformity in which there is non-union of the bones at the symphysis pubis; it is usually associated with extroversion of the bladder and epispadias; pelvis fissa. *See* Labour, Precipitate and Prolonged (*Rarer Forms of Pelvic Deformity, Split Pelvis*).

Spodo-.—In compound words *spodo-* (Gr. σπόδος, ashes or embers) means relating to waste material; e.g. *spodogenous* (produced by waste material), *spodophagous* (destroying waste material), and *spodophorous* (carrying waste material).

Spogel Seeds. *See* Isphaghula.

Spondylarthritis. — Inflammation of a spinal articulation (Gr. σπονδύλη or σφόνδυλος, a vertebra).

Spondylitis.—Inflammation of a vertebra, *e.g.* in spinal caries, and in rheumatoid arthritis of the spine (*spondylitis deformans*). *See* Spine, Surgical Affections of.

Spondylizema. — The morbid change in the vertebral column when through the destruction of one vertebral body the vertebra immediately above it sinks into its place (Gr. σφόνδυλος, a vertebra, and ἵζω, I sit down). *See* Labour, Precipitate and Prolonged (*Rarer Forms of Pelvic Deformity, Pelvis Obtecta*).

Spondylo-.—In compound words *spondylo-* (Gr. σφόνδυλος, a vertebra) means relating to a vertebra or to the spine; e.g. *spondylodynia* (pain in a vertebra), *spondyloptosis* (displacement downwards of a vertebra), etc.

Spondylolisthesis. — Displacement forward and downward of a vertebra (especially of the fifth lumbar) into the brim of the pelvis, causing the deformity known as *pelvis obtecta* and constituting a grave complication of labour (Gr. σφόνδυλος, a vertebra, and ὀλισθάνω, I slip). *See* Labour, Precipitate and Prolonged (*Rarer Forms of Pelvic Deformity*); Spine, Surgical Affections of (*Spondylolisthesis*).

Spondyloschisis.—Imperfect ossification and incomplete union of the outer articular parts of the vertebral arch, usually of the fifth lumbar vertebra.

Spondylotomy.—Division of the spine by strong scissors as a means of expediting the delivery of the fœtus in impacted shoulder cases, etc. *See* Labour, Operations (*Embryulcia*).

Sponge Tent. *See* Gynæcology, Diagnosis in (*Cervical Dilatation, Slow*).

Sponges. *See* Aseptic Treatment of Wounds (*Disinfection of Sponges*).

Sponging. *See* Antipyretics (*Uses, Recent Practice*); Hydropathy (*Methods, In Acute Diseases, Sponging with Cold or Iced Water*).

Spongioblasts. — The sustentacular (neuroglial) elements of the developing nervous system in contrast with the neuroblasts or future neurons. *See* Embryology (*Embryo in the Fourth Week*).

Spongiopiline.—Felted cloth coated on one side with rubber and having tufts of sponge incorporated with it on the other side (Gr. σπόγγος, sponge, πῖλος, felt); it has a poultice-like action when applied to the skin.

Spongy Portion.—The part of the male urethra contained in the corpus spongiosum of the penis.

Spontaneous Amputation. *See* Pregnancy, Intra-Uterine Diseases of the Fœtus (*Congenital Amputations*).

Spontaneous Evolution. *See* Labour, Diagnosis and Mechanism (*Transverse Lies, Spontaneous Delivery*).

Spontaneous Rectification. *See* Labour, Diagnosis and Mechanism (*Transverse Lies, Spontaneous Delivery*).

Spontaneous Version. *See* Labour, Diagnosis and Mechanism (*Transverse Lies, Spontaneous Delivery*).

Spoolworm.—The oxyuris vermicularis. *See* Parasites (*Ascaridæ*).

Spoon. *See* Prescribing (*Weights and Measures*); Metric System.

Spoon Curette. *See* Curettage (*Instruments*).

Spoon-Nails. *See* Nails, Affections of (*Alterations in Curvature, Koilonychia*).

Sporadic.—Occurring in a separate or isolated manner, especially in reference to diseases which are generally epidemic (Gr. σποράς, scattered); *e.g.* sporadic cholera, sporadic plague, etc. *See* Epidemiology (*Sporadic Diseases*); Meningitis, Epidemic Cerebro-Spinal (*Sporadic Form*); Mental Deficiency (*Sporadic Cretins*).

Sporangium. *See* Micro-Organisms (*Hyphomycetes, Asexual Reproduction*).

Spore.—A seed or reproductive body, especially of bacteria and other low vegetable forms. *See* Micro-Organisms (*Reproduction*).

Sporo.—In compound words *sporo-* (Gr. σπορά, a sowing) means relating to seeds or spores; e.g. *sporoblast* (a spindle-shaped cell derived from a zygote, as in the malaria organism), *sporocyst* (mother-cell of a spore), *sporocyte* (later stage in the development of a sporoblast, *e.g.* in the malaria organism), *sporozoa* (parasitic protozoa), *sporozoids* (sporoblasts set free from the the zygote), etc.

Sporozoa. *See* Leucocythæmia (*Causation and Pathology, Sporozoa*), Parasites (*Protozoa*).

Spot.—A small area of the skin or other part differing in colour from the surrounding surface; a macula or spilus. In the eye there is the *blind spot* (where the optic nerve enters the retina); there is the *germinal spot* in the ovum; there is the macula lutea or *yellow spot* of the retina (area of clearest vision); and there are post-mortem spots on the pericardium known as *milk-spots*.

Spot Culture.—The cultivation of typhoid bacilli from the blood got from the rose spots characteristic of that fever.

Spotted Fever.—Epidemic cerebro-spinal meningitis, or, sometimes, typhus fever. *See* Meningitis, Epidemic Cerebro-Spinal (*Symptoms, Skin Lesions*); Typhus Fever (*Period of Advance, Rash*).

Spotted Sickness.—*See* Pinta.

Sprains. *See* Ankle-Joint, Region of, Injuries (*Sprains*); First Aid; Hip-Joint, Injuries of (*Sprained Hip*); Knee-Joint, Injuries of (*Sprains*); Shoulder, Diseases and Injuries of (*Sprains*).

Spraying. *See* Disinfection (*Room, Throat, Carbolic Spray*, etc.).

Sprays. *See* Larynx, Acute and Chronic Inflammations (*Laryngitis, Treatment*); Nose, Acute Inflammation (*Local Treatment*); Prescribing and Methods of Administering Drugs (*By Mucous Membranes, Sprays*).

Spring Catarrh. *See* Conjunctiva, Diseases of (*Spring Catarrh*).

Spring Finger. *See* Deformities (*Acquired, Jerk- or Snap-Finger.*)

Spring Water. *See* Water (*Sources*).

Sprue.

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See also Nose, Diseases of Nasal Orifices and Septum (*Affections of Septum, Ulcerations*).

Synonyms.—*Psilosis linguæ* (Thin); *Ceylon sore mouth; Tropical aphthæ; Chronic tropical diarrhœa; White flux; Aphthaco-gastro-enteritis tropica; Seriawan* (Malay).

Definition.—Sprue is characterised by a chronic catarrhal condition of the alimentary canal from the mouth to the anus, accompanied by tenderness of the tongue, throat, and gullet, aphthæ of the tongue and gums, diarrhœa of a special character, and a gradual atony and physiological incompetency of the organs and fluids of digestion. During the course of the disease there are fluctuations of improvement and relapses, which may end in recovery, or in anæmia and fatal exhaustion.

Geographical Distribution.—Sprue seems to be endemic in India, Ceylon, the Malay Peninsula, the Malay Archipelago, Annam and Tonquin, the Antilles, the coast and river ports of China, and in some of the ports of Japan. Hillary described an affection resembling sprue in Barbados in 1776. The disease is mostly met with amongst white people in these countries, although natives are not exempt. The question as to whether the disease occurs in Japan is no longer doubtful, the writer having recently met with the disease in Europeans who have long been resident there.

Etiology.—The immediate cause of sprue is not known. Confined as it is to tropical and subtropical countries, it would appear that heat and moisture have a direct influence in its production, but the absence of the disease from countries with similar climate other than those mentioned above, would appear to imply the action and presence of some other factor. Many attempts have been made to discover the cause, the mode of investigation being mostly examination of the stools of persons suffering from sprue; no conclusive evidence has, however, been

advanced. Normand, in 1876, found in the stools of French soldiers who had returned from Cochin-China to Toulon, suffering with chronic diarrhœa, two nematodes to which he ascribed the disease. Bavay named the larger of these worms the *Anguillula intestinalis*, and the smaller the *Anguillula stercoralis*. Leuckart subsequently showed, however, that the former of these, the *A. intestinalis*, was the parent, and that the *A. stercoralis* was the embryo of the same species. Leuckart renamed the parasites the *Rhabdomenas trongyloides*. That this parasite, however, has anything to do with the causation of sprue is more than doubtful, for sprue occurs without the parasites being present, and the geographical distribution of the parasite is much wider than that of sprue. Begg, from the fact that santonin in his hands gave good results in the treatment of sprue, believes that an intestinal worm, probably the round-worm (*Ascaris lumbricoides*), is the cause of the disease. The writer is of opinion that food in some form is to blame, especially in persons whose digestive functions are impaired by prolonged climatic influences. Of these foods the crude and acrid vegetable oils used especially by Chinese and Malay cooks are the most likely to cause gastro-intestinal catarrh. In India ghee, or some one of the many adulterations of or substitutes for ghee, may serve as a cause. As sprue does not occur amongst recent arrivals in the tropics, but usually after ten or fifteen years' residence, the writer's opinion is that the prolonged irritation of the alimentary canal by the use of such oils is a possible cause of the ailment. The oils used by these native cooks are the oil of the rape plant, which, however, is frequently adulterated with hemp oil, rosin oils, or even mineral oils. The Chinese use also the oil from the ground (pea) nut, from the tea-oil-plant, a species of camellia, and even vegetable tallow derived from the *Stillingia sebifera*, as a substitute for animal fat.

A bacterial origin of the disease has been many times believed to have been found. Thin found a rod-shaped bacterium in the fæces of sprue cases and in cultivation experiments; a similar bacterium is described by Wethered. The writer believed he had in 1893 isolated a bacterium, but abandoned the conclusion on further investigation.

Europeans are more liable to sprue than are natives. Of 203 cases collated by Van der Burg in Java and Sumatra, 171 were Europeans and but 32 natives.

Long residence in a warm climate favours the development of sprue. It is seldom that Europeans until after a residence of ten years in a hot country contract the disease. Sprue may, however, defer its appearance until after a tropical environment has been changed for a temperate.

Women are more often attacked than men. Middle-aged persons are more liable than the young or the old to acquire the disease, but no age is exempt.

Chronic ailments, more especially those of an intestinal origin, predispose to sprue, so also does a lowered vitality from almost any cause. As usual in a disease arising from a scientifically undetermined cause, there are many theories as to origin in addition to the above, such as bad food, chronic dysentery, frequent confinements, miscarriages, and other feminine ailments, chills, curry, cold drinks, the exhibition of mercurials, more especially calomel, and the abuse of alcohol. In regard to alcohol opinions are divided, but it would appear that the disease occurs amongst total abstainers as well as heavy and moderate drinkers, but in what proportion is unknown.

Clinical Features.—Sprue commences so insidiously, and its early stages run their course with so few distinctive features, that it is impossible to date exactly the period of invasion.

Premonitory signs and symptoms of sprue consist of attacks of sore tongue and tender gums, with the formation of follicular ulcers on the several parts of the oral cavity. The attacks last about three weeks, increasing during the first week, reaching a climax of mouth tenderness, with aphthæ, during the second, with gradual subsidence during the third week. During the attack the patient is easily fatigued, becomes irritable and dyspeptic, and may or may not have an attack of diarrhœa. Recurrences of sore mouth may be frequent, as many as five or six in the year; they may continue for several years, only to disappear when the patient takes up residence in a temperate climate, or they may end in sprue. It is usually stated that the patient suffers from gastro-intestinal catarrh before the mouth tenderness. This may be the case, and probably is the fact, but the former is less troublesome, and attended by less discomfort than is a sore mouth, so that the soreness is remembered, whereas an evanescent dyspepsia or intestinal flux is neglected and forgotten. In the writer's opinion irregular and recurrent mouth tenderness unattended by intestinal flux precedes the establishment of the actual disease. As sprue gains a hold on the patient the symptoms complained of are diarrhœa, tenderness of the tongue and mouth, and dyspepsia.

Diarrhœa may commence quite insidiously, a slight looseness of the motions by its persistence attracting the patient's attention. On the other hand, the diarrhœa may be acute at the onset, and after a week or two develop into an established intestinal flux of a less severe character. The most frequent form, however, is that in which the patient is called out of bed in the early morning by a desire to go to stool. Before breakfast a second stool may be passed, and soon after the meal a third. Up to about

eleven or twelve o'clock in the forenoon stools may pass at intervals of one or two hours, but after noon the patient seldom has to go to stool. In the late stages of the illness the patient is usually called to stool about two o'clock in the morning, in addition to the early morning stools.

The *character of the stool* varies with the stage of the disease, with the food taken, and with the treatment. Neither the frequency of defecation nor the bulk of the motion is in exact relation to the stage or intensity of the illness, frequency of stool being sometimes associated with but slightly marked tenderness of the mouth or constitutional derangement. The motions are at first usually quite loose, consisting of a watery evacuation without blood, with but little or no mucus and of a pale yellow colour. The motion may escape with considerable force, attended by some griping, and is usually followed by a feeling of weakness, and occasionally clammy perspiration. As the illness advances the stools become less liquid and more pultaceous in character. The stools are of a dirty white colour, and of the consistence of thick mud. At times, and for a week or weeks together, the stool may be frothy, bulky, and fermentative in appearance, a condition which may alternate with one during which the stools assume the thick, muddy appearance described, and quite devoid of gaseous fermentation. The consistence and appearance of the stools harmonise with the state of the mucous membrane of the alimentary canal. During an acute spell of tender tongue, associated with stomachic and intestinal catarrh, the stools are of a fluid character; when the acute attack wears off the stools again become muddy in consistence. It would appear (*a*) when diarrhœa is present as though the stools passed before fermentation had developed; (*b*) when the contents of the bowel are longer retained and are thicker, but with bubbles of gas, the intestinal fermentation would appear to have begun, but not completed before the motion took place; and (*c*) when the motion is like mud, and with but little or no gaseous admixture, the explanation would seem to be that the butyric and other fermentations are completed before the stool is passed. Towards the later stages of the fatal form of the disease the stools become watery, with a heavy, fetid, repulsive odour, of a dirty brown colour, alternating with one of light straw colour. The stool has an acid reaction, the bile pigments are almost entirely absent, but the bile acids are present, although in what proportion to the normal has yet to be ascertained.

Tenderness of the tongue may develop gradually, or it may appear as a sharp, sudden attack. At the ridge and tip of the tongue, red raised spots appear, which gradually spread over the entire surface. The tongue assumes a glazed appearance in consequence, as though its epithelial surface was shed. The papillæ disappear, the tongue shrinks in bulk and is at last protruded with difficulty. Shallow transverse fissures, small cracks, superficial erosions, and ulcerations appear, more especially on the edges of the tongue, on the gums, frenum, and inside the cheeks and lips, which in time appear reddened and bare of epithelial covering. The tongue is very sensitive, not only to salt and acid substances, but such apparently non-irritating substances as bread, potatoes, etc., give rise to pain in the mouth. The senses of taste and smell are also impaired in advanced cases. Discomfort in speaking and swallowing is commonly complained of in sprue, and occassionally profuse salivation.

An ulcer, described by Crombie, and named "Crombie's Molar Ulcer," which appears between the two last molar teeth of either the upper or lower jaw, is considered by some to be a sign of commencing sprue. Dyspepsia in sprue is usually of the atonic variety, and attended by the feeling of fulness and uneasiness over the stomach, eructations, belching, heartburn, etc.; the appetite is variable, and vomiting may become pronounced, the vomit being mostly of a sour character, with a faint taste and odour, and with much mucus. Curiously enough, the vomiting most frequently occurs about midday. The mouth, fauces, and gullet feel so hot at times that the patient is tempted to sip cold or ice-cold water, or sucks ice persistently. The patient in course of time loses weight, the subcutaneous fat disappears, the skin becomes dry, harsh, and loose, the features appear drawn, the sclerotic is of a pearly white hue, anæmia becomes more marked, and œdema in advanced cases develops in the feet and legs. Irritability of temper, low spirits amounting even to melancholia, and progressive weakness increase as the ailment develops and in proportion to its severity.

The physical signs are chiefly confined to the abdominal organs. The abdomen, at first rather retracted, becomes somewhat distended at a quite early period in the disease, but its walls are soft, and the hand in palpation can be pressed deeply without any endeavour at resistance. In the last stages of fatal cases the abdomen sometimes shrinks and retracts, corresponding with the general emaciation. The liver shrinks in size at an early period of the disease, and it is even difficult at times to discover any hepatic area of dulness in long-standing cases of sprue. The other organs of the abdomen present no characteristic feature. The urine is usually limpid and light in colour, with a low specific gravity, and, except in the last months of illness in fatal cases, albumin in the urine is not met with.

Fever is not a distinctive feature in sprue. A temperature below the normal is the rule,

but during an attack of sore mouth there is a slight evening accession, and during the last few weeks or months of fatal cases a temperature between 100° and 102° or 103° F. is the rule. As weakness progresses a dry cough is often present, and the voice, at first hoarse and harsh, may be reduced to a whisper. The skin exhibits patchy brown pigment spots. Profuse night-sweats are frequently complained of. Slight inflammation of the rectum, attended by some blood and mucus in the stools, and with anal discomfort and pain, is common in fatal cases. The immediate cause of death is usually pneumonia or cardiac failure; the patient dies exhausted, worn out by the long period of physiological starvation of his tissues and organs. The duration of the disease is quite indefinite, amounting it may be to many years.

Pathological Anatomy.—The body appears shrunken and emaciated, as in a person dead from starvation. Unless some inflammatory changes have supervened, the lungs appear pale and shrunken. The liver may be pale or very dark in colour, or at times bile-stained; it is much reduced in bulk and weight. The spleen is small and usually anæmic. The stomach and intestine look pearly white, the stomach somewhat distended, the small intestines atrophied or contracted, and the large intestine distended and its wall well-nigh translucent. The mucous and submucous tissues are loosely adherent to the muscular walls, and are easily stripped off the intestinal surface. No ulceration is met with in the small intestine, but here and there erosions occur in the large bowel and in the rectum.

Microscopically examined, the epithelium of the intestine is found in parts to be lacking; the villi, Lieberkuhn's follicles, the solitary glands, and Peyer's patches are atrophied and in many parts have wholly disappeared. Other observations are a cirrhotic condition of the submucous coat, and cyst-like dilatations of follicles in the submucous coat, filled with a gummy, semi-purulent-looking material. Fatty or amyloid degeneration of the intestinal mucous membrane has been noted, and atrophy (occasionally enlargement) of the mesenteric glands.

Diagnosis.—Persistent mouth tenderness and diarrhœa are the two diagnostic features of sprue. Until these are established as something more than mere temporary derangements, such ailments as stomatitis, glossitis, and dyspeptic ulcers of the tongue may be mistaken for the beginning of sprue. When the disease is established the bare surfaces of the oral, faucial, and pharyngeal surfaces, the gastro-intestinal condition, the distinctive stools, and the accompanying loss of weight and anæmia characterise sprue with sufficient exactitude to allow of a positive diagnosis. The later stages of sprue resemble very closely the later stages of chronic dysentery, and it is chiefly by the antecedent history, in the absence of microscopic or bacteriological evidence, that a conclusion is arrived at. Amongst natives the condition of the mouth due to betel-chewing resembles very closely the appearance met with in sprue, but the red staining of the tongue and buccal cavity generally, and the absence of gastro-intestinal derangements in betel-chewers, at once differentiate the condition.

Prognosis.—Sprue is always to be regarded as a serious ailment. In persons over fifty recoveries are rare, but in younger persons, if the disease is treated early, and especially if the patient can leave the warm climate where he or she contracted the disease and reside in a temperate climate, good hopes of recovery may be entertained. One of the most grave complications of sprue is pregnancy, the patient usually dying immediately or within a few days after the child is born, be it at the full time or somewhat prematurely. The treatment involves so great an amount of self-denial that but few have the fortitude to go through an uninterrupted course of the dietetic restraint necessary.

Treatment.—*Dietetic Treatment.*—1. The pure milk treatment consists in putting the patient upon milk, and milk only, for some considerable period, it may be for many months. It is wise to commence by keeping the patient in bed for say a month at least. The milk may be taken cold, warmed, scalded or boiled, according to taste. There is no doubt that sterilised, freshly drawn milk is the best form in which to exhibit milk when this can be had. The quantity of milk to be given in the twenty-four hours should not be less than four pints nor more than six. The patient should be fed every hour or every two hours; the milk should be sipped slowly, or taken even with a teaspoon. Aeration of the milk by some one of the patent methods of aeration without diluting the milk is to be commended.

2. *Meat Diet.*—The writer advocates meat diet in place of milk, holding that cure is delayed by keeping the patient on milk. The effect of giving milk only is to bring about a stool which may be solid, but which is little more than a mass of soft, cheesy material having neither the fæcal odour of a healthy stool nor with any of the evidence that the bile or intestinal juices are called into play. The atrophy of the liver is a marked pathological feature of sprue, and as milk does not call the liver of an adult into physiological activity, that organ continues to atrophy and to become less and less active. The régime pursued in advanced cases of sprue, when the patient is very weak and anæmic, is to put the patient to bed, to feed the patient every hour, even every half-hour, or in desperate cases every five minutes it may be, with teaspoonfuls or dessertspoonfuls of beef juice made from the fresh beef, not the prepared article; and to supplement this with scraped

beef, raw meat, beef jelly, calf's-foot jelly, or even plain jelly. As a drink, plain hot water in considerable quantity may be given with benefit: as alternative drinks, whey, made by precipitating the curd of milk by rennet; rice water, the water in which rice is boiled (conjee); rice tea, made by roasting rice until it is brown, and then making an infusion by pouring boiling water over it.

As the patient's strength improves, as in all probability it will, the intervals of diet may be increased, and raw meat sandwiches given occasionally. Soon finely minced beef, passed thrice or oftener through the mincing machine, beaten up into a thick cream with a little water and with salt added, is to be gradually "warmed" in a saucepan, and given in small quantities according to the strength of the patient. As the condition improves a baked apple may be added to the diet, and the simplest form of diabetic bread. Subsequently the patient is to be kept on underdone meat, chicken cream, steamed chicken, game; and, if the diarrhœa is in abeyance, rice, well steamed and dried, is tolerated when the simplest form of milk pudding will cause diarrhœa or flatulence. Should the patient not be alarmingly feeble, he may be placed on meat, thoroughly minced, and carefully "warmed" at once, giving 5 oz. at a time and thrice daily. Between meals the patient is to have beef jelly, chicken jelly, or plain jelly to satisfy the cravings of appetite, for he must never be allowed to be hungry. When the patient wakes at night he must be fed systematically.

The very first meal of a "meaty" nature will bring down a bile-stained motion. Pent up so long, there is a tendency for bile at first to cause looseness, which, however, must not induce the practitioner to change the diet, or to administer drugs whereby to check the diarrhœa. It is an axiom in the treatment of sprue that astringents, given with the purpose of arresting diarrhœa, are a mistake. When the diarrhœa increases, or the stools show signs of fermentation, the writer invariably administers a teaspoonful or two of castor oil, with the object of sweeping away the offending material, instead of attempting to retain it in the bowel to work further mischief.

The shrunken liver will, by this treatment, be found to increase rapidly in size, the distension or retraction of the abdomen will subside, but the cure will not be effectual until the liver regains its normal size.

As adjuncts to this system of diet the patient must be kept in bed, it may be for a few days only. A wet pack, warm at first, but used cold as soon as possible, should be applied to the abdomen night and morning for two hours at a time. The "pack" must be kept firmly in place, so as to exercise some compression, by a large bath-towel wrapped round the body, pulled tightly, and secured by safety-pins. Between the applications of the wet pack a pad of flannel or cotton-wool, also tightly supported by a body-bandage, should be placed over the abdomen.

The Fruit Cure.—The good obtained by Van der Burg in Java by freely administering such fruits as strawberries, apricots, peaches, apples, pears, bananas, grapes, and even such fruits as mangostenes, melons, etc., peculiar as it may seem, is commendable as a reserve method of treatment. Thin found strawberries efficacious. The *rationale* of the treatment may consist in the fact that a scorbutic element is present in sprue, a condition by no means unlikely.

Drugs play but a small part in the treatment of sprue. Bael fruit has been tried in British India and in Siam. The fruit must, however, be recently prepared from perfectly fresh fruit; it is doubtful if the preparations made from the dried fruit, or that have been long kept, are of value. Santonin, in the opinion of Begg, in Hankow, China, holds a high place as a remedial agent in sprue. He insists that the santonin should be of the yellow (impure) variety, or rendered yellow by exposure to light. Begg first administers a dose of castor oil, and then gives six doses of santonin of three grains each. Other drugs, such as bismuth, papain, mercurial salts, sulphuric acid, opium, vegetable charcoal, have all been employed, whereby to treat symptoms as they arise, but with no specific intent.

The local condition of the mouth is at times so troublesome as to require relief. Painting the tongue with 1 to 10 per cent of solution of cocaine before taking food is rational and efficacious in allaying pain and allowing food to be taken. Rinsing out the mouth when there is much buccal ulceration with 1 per cent solution of carbolic acid affords relief and promotes asepsis. In place of carbolic acid, mouth washes of alum, chlorate of potash, and even common salt may be tried. Van der Burg recommends rinsing the mouth out with a tincture made from the rind of the *Heterocarpus indicus*. When ulcers are troublesome, touching their surfaces with sulphate of copper favours a return to a healthy action.

Hill Diarrhœa

Observations made in many parts of the world point to the prevalence of an intestinal flux when a high altitude is reached. At the hill stations in India this phenomenon has been more frequently observed than elsewhere. This is, in all probability, owing to the fact that more Europeans seek the hill stations in Northern India than in any other country; and, perhaps, the fact that the heights are quickly reached from plains where intense heat prevails, serves to increase the tendency to the complaint in this part of the world.

The *etiology* of hill diarrhœa is not known,

but in all probability it is due to a sudden change upon the economy caused by marked atmospheric changes in the temperature, in the barometric pressure, and in the humidity. The action of the skin being checked, partly by the fall in temperature at high altitude, and partly by the increased humidity, extra work is thrown upon other excretory organs which, until the balance is adjusted, may show itself in increased excretory activity of the lungs, the kidneys, and the intestines. There may be some further direct cause for hepatic insufficiency and portal congestion which determines the flux being intestinal. The height at which hill diarrhœa is observed is anything from 1000 to 10,000. When the complaint was first recorded an elevation of 6000 was the lowest level at which it was stated to appear, but during recent years hill diarrhœa has been observed at much lower levels. The writer observed that many residents near the seashore in Hong-Kong had diarrhœa for a week or two on taking up their abode at about 1000 feet above sea-level. Other theories of causation have been advanced. The unfiltered and unsettled water from mountain streams in the Himalayas are stated to contain fine particles of mica and grit, and to the mechanical irritation produced by these hill diarrhœa has been attributed. So far, therefore, a climatological and mechanical explanation has been sought, but the cause may belong to bacteriological or other factors, of which at present, however, nothing is known.

Signs and Symptoms. — Immediately upon reaching an altitude of, say, a few thousand feet above a tropical plain, some persons are liable to be attacked by a looseness of the bowels characterised by several peculiar and distinctive features. The stools begin usually about 4 A.M., and between that hour and noon some six or seven stools occur. The patient wakes suddenly with an intense desire to go to stool. The motion is attended by a sense of relief, and with but little griping or tenesmus. Stools are repeated, it may be every hour up to say 11 A.M., and they then cease for the rest of the day, to recur only in the early morning of the following day. With almost mathematical regularity do these stools appear for days, or even weeks, until, in fact, the patient becomes acclimatised, or until he seeks relief by returning to the plains. The motions vary in consistence, being at times watery, but more often of a thicker, pasty character, and of a dirty white or pipe-clay appearance. Flatulence and dyspepsia are marked accompaniments of the troublesome diarrhœa, the abdomen becoming prominent and flabby from gaseous distension of the stomach and intestines.

Diagnosis.—The sudden appearance of pipe-clay loose motions occurring during the earlier part of the day when a high, or fairly high, altitude is reached, and disappearing when lower levels are revisited, serve to sufficiently distinguish hill diarrhœa from other forms of intestinal flux.

Prognosis.—After a week or two hill diarrhœa may disappear spontaneously, the patient becoming acclimatised; on the other hand, the complaint may require the patient to return to the plains, owing to persistence of the symptoms, and to the development of considerable debility. In some cases sprue has been observed to result from hill diarrhœa.

Treatment by rest, diet, and drugs affords relief in some cases. A milk diet is usually prescribed, and with occasionally excellent results. Several aids to digestion, such as pepsine, lactopeptine, acids, peptonised foods, etc., are beneficial; and Crombie (*Indian Medical Gazette*, Dec. 1880, May 1892) advocates well-diluted drachm doses of liquor hydrargyri perchloridi after meals.

Spurious.—False, imaginary, or bastard; *e.g.* in such terms as false or *spurious labour pains* and *spurious pregnancy* (pseudocyesis). *See* PSEUDOCYESIS; OVARIES, DISEASES OF (*Ovarian Tumours, Diagnosis*).

Sputum. *See* EXPECTORATION AND EXPECTORANTS. *See also* ASTHMA (*Symptoms*); BRONCHI, BRONCHITIS (*Etiology, Micro-organisms in Sputum*); BRONCHI, BRONCHITIS (*Clinical Varieties, Fœtid Bronchitis*); CHILDREN, CLINICAL EXAMINATION OF (*Respiratory System, Sputum*); HYDATID DISEASE (*Pulmonary Echinococci*); LUNG, TUBERCULOSIS OF (*Expectoration*); LUNGS, GANGRENE OF (*Symptoms*); LUNGS, PARASITIC AFFECTIONS OF (*Aspergillosis*); MEDIASTINUM (*Cancer, Symptoms, Cough*); PNEUMONIA, CLINICAL (*Clinical Features, Sputum*).

Squama.—A scale, *e.g.* of the epidermis; or scale-like bone, *e.g.* the squamous part of the temporal bone.

Squamipinnes. *See* SNAKE-BITES AND POISONOUS FISHES (*Coral Fish or Squamipinnes*).

Squamo-.—In compound words *squamo-* (Lat. *squama*, a scale) means relating to a scale or to a scale-like bone, such as the squamous temporal; e.g. *squamo-sphenoid* (belonging to the squamous part of the temporal and to the sphenoid bone), *squamo-zygomatic* (belonging to the squamous and zygomatic parts of the temporal bone).

Squamous.—Scale-shaped or scaly, or related to parts which are scale-like; *e.g.* the *squamous suture* of the skull (between the squamous temporal and the frontal and parietal bones).

Squill.—The sliced bulb of *Urginea scilla*, a plant of the Mediterranean coast. The most active principle is *scillitoxin*, and there are also

present *scillipicrin* and *scillin*. *Dose*—1-2 gr. *Preparations*—1. Tinctura Scillæ. *Dose*—5-15 m. 2. Syrupus Scillæ. *Dose*—½-1 ʒ 3. Oxymel Scillæ. *Dose*—½-1 ʒ. 4. Acetum Scillæ. *Dose*—10-30 m. 5. Pilula Scillæ Composita. *Dose*—4-8 gr. 6. Pilula Ipecacuanhæ c. Scilla. *Dose*—4-8 gr.

The action of squill resembles closely that of digitalis, but it is a much more powerfully irritant drug. It may set up severe gastro-intestinal disturbance; and while being excreted it exerts an expectorant and a diuretic action. It is largely employed as a diuretic in dropsy, especially when of cardiac origin, and should be combined with digitalis in such cases. A favourite pill contains squill, digitalis, and blue pill, one grain of each. As an expectorant also it is invariably administered in combination with other drugs. It is especially helpful as an ingredient of cough mixtures for chronic bronchitis when the expectoration is scanty and tenacious, or when a very copious secretion is incompletely expectorated. It should not be given in acute bronchitis on account of the increased congestion of the mucous membrane produced. It should be discontinued if it sets up dyspeptic trouble.

Squill, Indian. — Urginea or Indian Squill is obtained from the younger bulbs of *Urginea indica* and of *Scilla indica*; it acts in the same way as ordinary squill, and it is included in the Addendum to the B.P. of 1898 (published in 1900). There are six official preparations: (1) the *Acetum Urgineæ* (dose, 10-30 m.); (2) *Oxymel Urgineæ* (dose, ½-1 fl. dr.); (3) *Pilula Ipecacuanhæ cum Urginea* (dose, 4-8 gr.); (4) *Pilula Urgineæ Composita* (dose, 4-8 gr.); (5) *Syrupus Urgineæ* (dose, ½-1 fl. dr.); and *Tinctura Urgineæ* (dose, 5-15 m.).

Squinting. *See* Strabismus and *Cross References*. *See also* Brain, Cerebellum, Affections of (*Tumour, Symptoms, Ocular Nerves*); Conjunctiva, Diseases of (*Ophthalmia Neonatorum, Sequelæ*); Ocular Muscles, Affections of (*Paralysis*); Tetany (*Motor Symptoms*).

Ss.—Abbreviation of *semis*, one-half. *See* Prescribing (*Abbreviations*).

Stabs. *See* Medicine, Forensic (*Various Kinds of Wounds*).

Stacke's Operation. *See* Ear, Middle, Chronic Suppuration (*Treatment*).

Stadium.—A stage, *e.g.* the *stadium decrementi* in a fever (stage of defervescence).

Staffordshire Knot.—A method of ligaturing the pedicle of a tumour, etc., introduced by Lawson Tait in ovariotomy: a double ligature is carried through the pedicle, the loop is then brought over the tumour and one of the ends brought out above it, the ends are then drawn tight and a reefing knot tied on them.

Staggers. *See* Hydatid Disease.

Stahl's Ear.—A congenital deformity of the outer ear consisting in a flattening and folding over of the helix, so that the fossa ovalis and the scaphoid fossa are not visible.

Stains and Staining. *See* Post-mortem Methods (*Staining of Sections*).

Stalk.—A pedicle or lengthened support of an organ or part (normal or morbid); *e.g.* the allantoic stalk, optic stalk, etc.

St. Amand. *See* Balneology (*France*).

Stammering.

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See also Hypnotism (*Therapeutic Uses, Stammering*); Hysteria (*Disorders of Respiration*).

Stammering (or stuttering) is a functional affection of speech, and in order to understand its causation and treatment it will be necessary, in the first place, to give a brief analysis of the processes concerned in the production of ordinary speech, and, secondly, to note what alteration in the processes causes this affection.

Speech consists of words. Words are combinations of vowels and consonants.

In the formation of these vowels and consonants the concerted action of three separate mechanisms is necessary:—

I. The respiratory mechanism to supply the breath which puts the vocal cords into vibration.

II. The laryngeal mechanism. This consists of two parts: (*a*) the true vocal cords, which, by their vibration, give rise to the voice or sound of speech; and (*b*) the false vocal cords, which control the exit of the breath.

III. The oral, or rather the oro-nasal mechanism, which, by means of the lips, teeth, tongue, and soft palate, moulds the voice into the different vowels and consonants. A vowel has been defined by Ellis as "a modification (due to resonance in the cavities above the larynx) of an original quality of tone, produced by the vibrations of the vocal cords in the larynx." Every vowel is a continuous voice sound, and calls the above three mechanisms into play.

Consonants may be divided into two main groups: (1) Breath or voiceless consonants, in which there is no voice sound; and (2) Voiced consonants, which have the same oral position as the first group, but have in addition a concomitant voice sound. The following table represents the physiological alphabet constructed

by Alexander Melville Bell in 1849. In it the consonants are placed in parallel lines :—

Voiceless.	Voice.	Voice + Nasality.
p	b	m
f	v	
wh	w	
t	d	n
th	th (dh)	
	l	
	r	
s	z	
sh	zh	
	y	
k	g	ng

On referring to the table, it will be seen that in order to form the breath consonants the breath is completely obstructed at three points :—

(1) By contact of the lips.

(2) By contact of the tip of the tongue with the anterior part of the palate.

(3) By contact of the back or root of the tongue with the posterior part of the palate. At the first of these points are formed the articulations *p* and *b* ; at the second *t* and *d* ; and at the third *k* and *g* ("hard") ; the former of each of these parts being the "breath," and the latter the "voice" forms of the articulation. While the oral organs are in obstructive contact the breath or voice may be made to issue *by the nostrils*. This is the mode of formation of the English elements *m*, *n*, and *ng*. For *m* the lips are closed, as in forming *p* and *b* ; for *n*, the tongue is on the palate, as for *t* and *d* ; and for *ng*, the posterior organs are in contact, as in forming *k* and *g*.

F and *v* are formed by partial contact of the lower lip and upper teeth ; *th* and *th* (*dh*) by partial contact between the tip of the tongue and the upper teeth, and *l* by partial contact of the tip of the tongue and forepart of the palate, while the sides of the tongue vibrate freely.

In trilled *r* the tip, and not the side of the tongue, is allowed to vibrate, thus differing from *l* with which it is often confused. In *wh* and *w* there is merely approximation of the lips, and in *s* and *z*, *sh* and *zh*, and *y* approximation of different parts of the dorsum of the tongue to the hard palate.

In the formation of these consonants it is well to bear in mind that *l*, *m*, *n*, *ng*, *r*, *dh*, *z*, *zh*, *w*, and *y* can be compared to the vowels, in that they are all continuous voice sounds, and like them are seldom a cause of trouble to the stammerer. Any or every one of the other consonants, however, may present the greatest difficulty.

In the formation of the breath consonants there is one point of the utmost importance, which, so far as the writer is aware, is mentioned by Melville Bell, and by no other writer on the subject. As it is important not only in the correction of speech affections, but also constitutes a crucial distinction between good and bad voice production, it will be best to give it in his own words :[1]—

"The voice-organ and the articulating organs are entirely separate and independent ; and the elements of their respective utterances are not coalescent, but merely sequent, however rapid and close may be their apparent connection. All actions of the vocal organs which partially or wholly obstruct, or which compress the breath or voice, are called articulations (or consonants). The necessary effect of such obstructions or compression is a degree of explosiveness in the breath when the conjoined or approximated organs are separated. Hence arises an element of audibility produced by or with the mouth. When the current of unvocalised breath is altogether stopped by organic contact, as in *p*, *t*, *k*, the only audibility that the letter so formed can have is the puff or explosion which follows the separation of the organs. This must therefore be clearly heard, or the letter is partially lost. In the mode of producing this little effect lies one of the most important principles of speech—a principle on the right application of which depends much of a speaker's distinctness, and all his ease. *Here lies the point of importance. If only the breath in the mouth, and not any from the lungs, be ejected, a distinct sharp, quick percussion will be heard, which gives to these breath articulations all the audibility of which they are susceptible.* The want of pharyngeal power manifests itself by distension of the lips and cheeks for *p* and *b* ; by incontinency of breath for *t*, *k*, *d*, *g*, by laborious actions of the chest to create the explosive audibility of these letters ; by scattering the saliva for *s*, *f*, and other continuous elements ; and by general indistinctness of articulation. It is the want of power to retain the breath after consonants which causes the great difficulty that stammerers experience in joining consonants to succeeding vowels. They will often get smoothly over the consonants and stumble at the vowel. They must bear in mind that the breath in articulation is exploded from the mouth, and not from the chest. The space within which the air is compressed is *above* the glottis ; and the effect of the compression must not be communicated below the glottis. The quality of clear-cut articulation depends on the due separation of the functions of the vocalising and articulating organs. *The vocal sound seems to be unbroken, because the actions of the tongue and the lips, while interwoven with it, do not interfere with it.*

"All singers and all speakers may attain this bright excellence of articulation by forming con-

[1] Postscript on Elocution.

sonants with the economic impulses of the pharynx instead of the wasteful explosion of breath from the chest."

Even Wyllie, in his classic work, *The Disorders of Speech*, has failed to note this important practical point.

Thus in speaking of his physiological alphabet he says:—

"Before I proceed to draw up this alphabet let us consider, in the light of a few examples, the delicately co-ordinated action which is carried on in combination by the two mechanisms, laryngeal and oral, in the production of ordinary speech. Take the word *satisfy*. Here the laryngeal mechanism is called upon to touch off three separate vocal sounds, each of which is evolved by the vocal cords during an instant of approximation, viz. the sounds *a*, *i*, and *y*; *and, between these sounds, the open glottis must permit the current of air to pass noiselessly into the mouth, where it will be utilised for the production of the voiceless consonants*, which are made, as it were, to clothe the vowels in front and behind. Let the naked vowels, as they sound in this word, be pronounced, and then the full word itself; and the extreme delicacy and exactitude of the three separate co-aptations of the vocal cords will be realised. Let there be any delay in the pronunciation of the first vowel, and the initial *s* will be hissed and prolonged exactly as it is by the stammerer.

"But the voice is not an exclusive possession of the vowels; many of the consonants are also in part made up of voice. Take the word *wonder*, for example. Here every letter, consonant and vowel alike, contains voice; so that the larynx has to maintain its vocal cords in co-aptation throughout the whole word, which may even be repeated many times in a deliberate and continuous hum. But add to this word the final syllable *ful*; and as the word, with this addition, is being hummed over, note the moment of interruption of the hum during the production of the voiceless *f*. *For a moment the vocal cords have been thrown apart to permit of the passage of voiceless air for the* f; *but they are immediately brought together again for the production of the vocal* u. These examples may suffice to show what a delicate and exact work the larynx has to perform, in supplying the vocal element to the vowels and vocalised consonants, and in intermitting the voice production when the air is required for consonants that contain no voice."

A comparison of the statements of Bell and Wyllie respectively shows a fundamental difference between their conceptions of consonantal production. In the writer's opinion, not only is Bell's explanation the more accurate one, but it has the additional advantage of usefulness in the treatment of stammering. The practical lesson to be drawn from Bell's dictum is that it is not necessary to intermit the voice (as stated by Wyllie) in order to interpolate the consonants.

In addition to the above-mentioned three points of closure which have, by Wyllie, been aptly named the 1st, 2nd, and 3rd "stop positions" respectively, there is another point, at which the larynx can be completely obstructed, so that neither breath nor voice can issue. The discovery of this was made by Wyllie, and published by him in 1866. He then showed that there is in the larynx a double valve, consisting of the true and false vocal cords, and that the latter control the exit, whilst the former control the entrance of the air into the chest.

Bearing these facts in mind, we will now consider what takes place when a fit of stammering comes on. In some few cases there is a want of co-ordination between the respiratory and laryngeal mechanisms, and the patient may even try to speak without first inhaling. In the great majority of cases, however, the want of co-ordination is between the laryngeal and oral mechanisms. The result has been well described by Kussmaul, who gives the following graphic word-picture of a paroxysm of stammering:—

"He closes the oral canal at one or other of the closing points, according to the nature of the letter to be articulated, and this he does as well as a man who possesses the faculty of speech could do it; instead, however, of allowing the vowel to follow without delay, he presses his lips, or his tongue and teeth, or his tongue and palate, more firmly together than is necessary; the explosive escape of breath does not take place, the other muscles of the face and those of the glottis, and even the muscles of the neck, become spasmodically affected like those of articulation, gesticulatory movements are made, the abdomen is retracted, the head is drawn backward, and the larynx is drawn forcibly upward, until finally he works himself into a state of frightful agitation; his heart beats forcibly, his face becomes red and blue, his body is bedewed with perspiration, and he may present the appearance of a complete maniac."

In all such cases, voice, produced by the laryngeal mechanism, is wanting, and the stammerer, not knowing what is at fault, misdirects his energy into the oral mechanism. "From the nerve centres of oral mechanism thus surcharged," as Wyllie points out, an "overflow in many cases occurs." "The habit of overflow in the nervous mechanism of articulation wears, in time, easy channels for the overflow; so that very slight surcharge may eventually suffice to produce spasmodic movement of the neighbouring muscles."

When the obstruction is caused by the action of the false vocal cords the sufferer may stand with the mouth wide open, and perhaps with

the tongue protruded, and when the spasm is relaxed the words pour out until there is no breath left. On renewing the breath the same thing may occur again. This is the explanation of that less common variety of stammering in which the patient sticks at initial vowels. It is interesting to note how well this condition has been described by Shakespeare.[1]

Etiology.—The causation of stammering is somewhat obscure. It is said by many writers to be hereditary, and to occur especially in families with a neuropathic diathesis. Such an explanation, however, does not cover the whole field, because, as all speech is primarily due to imitation it is highly probable that cases of so-called heredity are really to be explained by imitation, and on the other hand many stammerers are not only in the beginning strong and healthy in themselves, but come of a healthy stock. When the affection, however, has persisted for some time, the daily and hourly worry and annoyance which it causes tends to produce other nervous symptoms, which, of course, will be doubly marked if the patient be of a nervous diathesis. The writer knows of one family in which the eldest child contracted the habit from a stammering nurse, and the five younger members all became stammerers. The youngest member, having had five bad examples, is much the worst. It is an interesting fact, also, that in two at least of the family the stammer disappears on removal from the family circle for a short period, and reappears on rejoining it.

The commonest cause, however, is undoubtedly imitation. In most cases the imitation is unconscious, but in some it is done to tease and annoy a companion, and is persisted in until "the biter is bit."

A sudden shock or fright has sometimes been the starting-point, or a severe and unmerited whipping at school. In some instances the affection has come on during convalescence from severe illness, such as typhoid fever or diphtheria. In the latter paralysis of the soft palate or diaphragm may have been a factor in the case.

It has been stated that it does not occur in Jews owing to their being circumcised, but two of the author's cases have been Jewish boys, one of whom had an elder sister who also stammered. The occasional association of stammering with adenoid growths in the naso-pharynx has also been noted.

Many other sources of peripheral irritation, such as intestinal worms, or the eruption of a permanent molar tooth, or a tight prepuce, may act as exciting causes.

Prognosis.—On the whole this is favourable. Some cases get well without special treatment. A certain number are cured by so-called "stammer-doctors," but, on the other hand, a certain number get worse under their treatment, or in addition to the stammer may acquire other habits equally objectionable and annoying to the bystander, such as beating time with the foot or hand, or nodding of the head. Others may have been cured by properly qualified teachers who have studied the subject on scientific principles.

But over and above all the cases of cure, there are some stammerers who have been taught what they ought to do, and who can do it, when reading or reciting aloud to themselves or speaking to their teacher, yet the moment they are called on to take their part in daily life and to mix with strangers the stammer reappears, after perhaps months of hard work, and their case becomes as distressing as ever.

In such cases, otherwise intractable, it has come within the writer's experience that hypnotism is sometimes of great benefit, and no case should be pronounced incurable until this has been tried.

Treatment.—The first step in the treatment is to attend to the patient's general health, and to remove all sources of peripheral irritation which may have caused the patient to stammer, or tend to maintain the condition. The teeth should be attended to. The pharynx and naso-pharynx should be inspected for enlarged tonsils and adenoid growths, and if present they should be removed. All male patients should also be examined in regard to the condition of the prepuce. Even in Jewish children this is necessary, as the operation of circumcision is not always efficiently performed by the Rabbi, and the writer has seen a case in which there was distinct improvement in the stammering after the operation had been repeated by a surgeon.

Nervous and shy children should be removed from school, not only for their own sake, or because their life is often made miserable by the jeering of their companions, but also for the sake of the other children, who, by imitating them, may themselves become stammerers.

The practice of putting several stammerers into a special class, so that their education may proceed *pari passu* with the treatment of their stammer, cannot be recommended. Several patients have been brought to the writer who had been treated in this manner. Not only were the results unsatisfactory, but in some cases the affection had been aggravated.

The parents of stammerers seldom realise the importance of early treatment. They may be divided into two classes—(1) Those who pay no heed to the misery and discomfort which may be caused in childhood, or to the disabilities to

[1] "I prithee, tell me who is it quickly, and speak apace. I would thou couldst stammer, that thou mightst pour this concealed man out of thy mouth, as wine comes out of a narrow-necked bottle, either too much at once, or none at all. I prithee, take the cork out of thy mouth that I may drink thy tidings."—*As You Like It*, Act III. Scene 2.

which the affection may lead in after life; and (2) those who do not fail to recognise the desirability of treatment, yet are unwilling to have their child removed from school in order that the treatment may be effectually carried out.

In the case of a boy at a public school, there can be no doubt that it is much better and really a saving of time to have the boy kept from school for a term, or for such longer period as may suffice to get rid of the stammering and establish a habit of correct speech.

Stammerers as a rule, if the habit has persisted for any length of time, are deficient in initiation and in tenacity of purpose, and they may be roughly divided into two classes, viz.: those who are anxious to be cured, and those who are totally indifferent. With the latter class, of course, nothing can be done. But many boys who have not got to an age to be able to appreciate the importance of being cured, and are unwilling to submit to treatment if carried on during their holidays, are yet willing enough learners if they be kept from school and treated during term time. This difficulty, which the writer has experienced several times, does not occur with girls, perhaps because they have not got such a keen sense of justice in regard to the proper employment of their holiday time.

In the case of a very young child a successful cure may often be obtained by gently but firmly insisting on the repetition of the letter or letters over which the child has stumbled, until they can be pronounced quite smoothly. This can easily be carried out by the mother or governess. In treating a person old enough to reason for himself it is difficult to lay down any general rules, as each case must be dealt with individually, and much depends on the aptitude of the pupil and on the ability of the teacher. The teacher must, however, first succeed in gaining the complete confidence of the patient, without which it is useless to attempt the cure. For this reason, therefore, it often happens that one teacher may succeed where another has failed, even though both are teaching on the same lines.

The fundamental fact which the stammerer must grasp before any progress can be made, is that his voice sound must be made as far as possible a continuous one.

The method of treatment which will now be shortly explained is based on that fact. It has proved successful in numerous cases, but at the same time, for the reasons above stated, the writer does not set it forth as a universal panacea.

It has been stated by several writers on the subject that most cases of stammering are due to a faulty method of respiration. Unfortunately this is seldom the case. If it were, the remedy would be so simple that no case would remain uncured. The fallacy of such a statement is also shown by making the stammerer sing or intone, when, although the method of respiration is the same during singing as it was during speaking, the stammer disappears, since during singing the demand for vowel sound in contradistinction to consonantal sound is paramount.

In the few cases in which the breathing alone is at fault, the patient tries to speak without sufficient air in the chest to set the vocal cords into vibration, or to keep them vibrating for more than a few seconds. This may be due to the fact either that he has not taken in enough air, or that he does not know how to control its exit, so that on the formation of the first vowel it escapes with a rush. The attempt is then made to speak while the chest is empty, and as no voice is forthcoming, the energy is then misdirected from the laryngeal into the oral mechanism, and stammering ensues. The cure of such a case can usually be effected by teaching the stammerer how to breathe and how to control the exit of the breath.

But though in a few cases the respiration is primarily at fault, nevertheless it will be found that few stammerers know how to breathe properly or how to control the exit of the breath. It will be observed, on testing with a spirometer, that their breathing capacity is small, and further that they cannot hold their breath for more than a few seconds. When the breathing capacity is small the chest is usually small also. It is a very widespread but mistaken idea that a large chest measurement means a correspondingly large breath capacity, but nothing could be further from the truth. Most gymnasts have a large chest measurement, but this is often chiefly due to development of muscles outside the chest, while the bony framework itself may be small and comparatively useless as a breathing machine. It is therefore of the utmost importance that the stammerer should increase his breathing capacity, not merely to supply the motive power which throws the vocal cords into vibration, but also to enable the chest to act as a resonating cavity, and so lessen the strain put upon the throat during voice production. Exercises, such as running, skipping, and hopping, which make use of the lower limbs, tend to increase the internal capacity of the chest more than ordinary gymnastics or wearisome exercises with dumb-bells, because in the former the ribs are free to move, whilst in the latter they are fixed so as to afford a point of resistance for the muscles which move the upper limbs.

Physiologists have usually divided breathing into two types: "ordinary," and "extraordinary" or forced. For the purposes of proper voice production, however, the breathing should be more than the "ordinary," which suffices to supply the need for oxygen when the body is quiet, and less than "extraordinary" or forced.

During ordinary breathing the diaphragm undoubtedly plays the chief part, but in the deep breathing which the stammerer should cultivate, the diaphragm has a less active rôle, and chiefly prevents the tendency of the abdominal contents to be aspirated into the chest, This can be seen on watching the upward movement of the diaphragm by means of the X-rays during a full inspiration. In this type of breathing the ribs move backwards and outwards. They also turn on their axes and are raised (by means of the serratus magnus), and carry the sternum forwards and upwards. In so doing they carry the inner ends of the clavicles, which are fixed to the top of the sternum, upwards and forwards. The chest is thus enlarged in all its dimensions with the least possible exertion. The front abdominal wall sinks in, but is not pulled in by muscular effort.

At the risk of repetition the writer particularly wishes to emphasise the fact that this method of breathing must not be confounded with forced, "extraordinary" or so-called "clavicular" breathing. In the latter the outer as well as the inner ends of the clavicles are actively pulled up, whereas in the former the inner ends only are moved, and they are passively pushed up from below by the upward and forward movement of the sternum.[1]

After the chest has been filled with air the breath should then be allowed to escape slowly with a very slight hissing sound made with the mouth open, and due to the escaping breath being controlled at the larynx by means of the false vocal cords. Practice will soon enable the duration of escape to be extended from ten seconds to sixty.

It may be thought that undue attention has been drawn to the question of breathing, but the writer has found that apart from the great improvement in general health which quickly follows, nothing gives the stammerer so much confidence as his ability to take a full breath and hold it or control its exit at will.

Let us now pass to consider the treatment of a case in which the stammer is due to the false vocal cords being so closely approximated that no breath can pass until the spasm has ceased. In such a case the initial vowels are usually the stumbling-block. The patient must therefore be taught to alter the ordinary conditions of voice production, and to produce each initial vowel by consciously permitting a slight escape of breath in the form of an aspirate, *ha-he-ho* instead of *a-e-o*. This preliminary escape of breath ensures a continuous flow of voice by preventing the spasmodic closure of the false vocal cords. This method, though ugly, must be continued until the stammerer has no fear of trying to pronounce an initial vowel. When this stage has been reached the preliminary and accompanying escape of breath can be gradually decreased, until it is finally possible to attack each vowel quite cleanly and with no preceding aspirate.

When the fault lies in the obstructive closure of the oral mechanism, it is first necessary to find out on which consonants the greatest difficulty is experienced. If the case is slight, one may begin with these consonants, but if it is severe it is better to leave the consonants which give the most trouble until the others have been dealt with.

In some few cases it is sufficient to point out to the stammerer that it is the lack of the voice-sound which causes the difficulty, and he is soon able to overcome it.

In most cases, however, definite exercises must be given in order to show the stammerer how it is possible to keep up a continuous or almost continuous voice-sound without interruption during the formation of the consonants.

For this purpose he should begin by intoning a vowel, say *o*, and continue it as long as the breath lasts. When this can be done for twenty seconds, an attempt must be made to form one of the "voiced consonants" without interrupting the flow of voice—thus *o-mo-mo*. In so doing the positions for the consonants are not to be firmly taken, and therefore their sounds will at first be quite indistinct. As the writer knows from experience how difficult it is in some cases to get the patient to hear that the voice-sound is being interrupted by the consonant, he would suggest that the exercise should be practised with the eyes shut and also with the ears closed. By this procedure it is possible to concentrate the attention much more easily on one's own voice, and so to hear the slightest interruption in the continuity of the sound.

Other things being equal, it will be found that the nasal sounds interrupt the tone least and are the best to begin with. After the exercise has been so mastered that it is possible to make the different consonants distinct without intermitting the continuous voice-sound, it must be repeated with the voiceless or breath consonants. This will be found to be very difficult, and in some cases requires long and arduous practice.

When the stammerer has succeeded in doing this, he should discontinue the intoning and try to do the same exercises in a drawling voice. He may then go on to words and sentences, and eventually to ordinary conversation.

At this stage some daily practice in reading aloud or repeating by rote should also be insisted on, and should be carried on for several months.

Even after the stammer has disappeared, it is liable to return if the patient gets run down or

[1] Fuller directions for the practice of this type of breathing, which is so essential for the stammerer, will be found in a small pamphlet called *Twelve Lessons on Breathing*, by George E. Thorp, published by Reeves & Co., London.

depressed, either from over-work or a severe illness. But the relapse is never so severe as the original affection, and is generally easily treated.

The duration of such lessons should at first be only half an hour. Two lessons of half an hour at different times in the day yield much better results than one lesson in one hour. Where possible, the lessons should be taken continuously for two or three weeks, and not spread over an interval of several weeks.

Standard.—Something, *e.g.* a solution containing a fixed quantity of a reagent, used for making comparisons.

Standardising.—The making of pharmaceutical preparations in such a way that a given quantity contains a certain fixed proportion of the active principle of the drug; the result is a *standardised preparation.* There are several such preparations in the B.P., including the *Tinctura Opii, Tinctura Nucis Vomicæ, Extractum Belladonnæ Liquidum, Tinctura Cinchonæ, Aqua Laurocerasi,* etc.

Stannius' Experiment.—An experiment (application of a ligature between the sinus and the auricles of the frog's heart) to prove that, while any part of the heart has the power of originating rhythmical contractions, it is the sinus which usually does so. *See* Physiology, Circulation (*Cardiac Contraction, Starting Mechanism*).

Stapedectomy.—Excision of the tympanic ossicle, known as the stapes.

Stapedius.—The name given to the muscle inserted into the neck of the stapes; it is supplied by the facial nerve. *See* Facial Spasm (*Symptoms, Spasm of the Stapedius*).

Stapes. *See* Ear, Examination of (*Anatomy of Tympanic Cavity*); Ear, Middle, Chronic Suppuration (*Recessus Epitympanicus, Excision of the Ossicula Auditus*); Ear, Middle, Chronic Non-suppurative Disease (*Atrophic Catarrh, Fixation of Stapes*); Physiology, Neuro-Muscular Mechanism (*Hearing, Middle Ear*).

Staphisagriæ Semina.—The dried ripe seeds of *Delphinium staphisagria* (*stavesacre seeds*), containing the alkaloid delphine (having an action like that of aconite) and a fixed oil, and used externally as a parasiticide in cases of pediculosis; there is one officinal preparation, the *Unguentum Staphisagriæ. See* Dermatitis Traumatica et Venenata (*Causal Agents, Vegetable*).

Staphyle.—The uvula (Gr. σταφυλή, a bunch of grapes). In compound words *staphylo-* means relating to the uvula; *e.g. staphyloplasty* (closure of a cleft palate), *staphylorrhaphy* (suture of a cleft palate), etc.

Staphylitis.—Inflammation of the uvula.

Staphylococcus. *See* Bone, Diseases of (*Pyogenic Diseases, Staphylococcus Aureus*); Ear, Middle, Chronic Suppuration (*Bacteriology*); Immunity (*Staphylococcal Infections*); Intestines, Diseases of (*Bacteria of the Intestinal Tract*); Joints, Diseases of (*Bacterial Diseases*); Lardaceous Degeneration (*Pathology*); Lung, Tuberculosis of (*Constitutional Symptoms, Pyrexia, Causes*); Lungs, Gangrene of (*Etiology*); Meninges of the Cerebrum (*Purulent Meningitis, Etiology*); Nose, Examination of (*General Examination, Bacteriological*); Nose, Accessory Sinuses, Inflammation of (*Bacteriology*); Parasites (*Echinococcus Disease*); Pemphigus (*Pemphigus Acutus Neonatorum*); Pharynx, Acute Pharyngitis (*Acute Septic, Hospital Sore Throat*); Pleura, Diseases of (*Bacteriology of Pleural Effusions*); Pneumonia, Bacteriological Section; Prostate Gland (*Hypertrophy, Septic Infection*); Sclerema Neonatorum (*Micro-Organisms*); Septicæmia; Skin, Bacteriology of; Suppuration; Teeth (*Oral Sepsis*); Tonsils, Diseases of (*General Considerations, Bacteria in Tonsillar Crypts*); Tuberculosis (*Mixed Infection*).

Staphyloma. *See* Sclerotic, Diseases of the (*Staphyloma*).

Staphylomycosis.—An infective process due to staphylococci. *See* Suppuration (*Nomenclature*).

Staphyloptosis.—Abnormal elongation of the uvula.

Staphylopyosis.—Suppuration due to staphylococci. *See* Suppuration (*Nomenclature*).

Starch.—Amylum or starch is obtained from the grains of wheat, of maize, or of rice; it is used in making dusting powders and insufflations, and as a basis for ointments and enemata; there is one official preparation, *Glycerinum Amyli. See* Bandages (*Fixed*); Physiology, Food and Digestion (*Carbohydrates, Starches and Glycogen*); etc.

Starvation. *See* Medicine, Forensic (*Death from Starvation*). *See also* Atrophy, Infantile (*Medico-Legal*); Lungs, Gangrene of (*Etiology, Predisposing Causes*); Temperature (*Alterations, Depression*).

Stasis.—Arrest of the circulation of the blood or of other fluids in the body, *e.g.* venous stasis (stasis due to venous congestion).

State Medicine.—Medical Jurisprudence and Hygiene. *See* Medicine, Forensic (*Definition*).

Statistics. *See* Vital Statistics.

Status.—A condition in which certain characters which it may have taken some time to develop are more or less continuously present; *e.g.* the *status epilepticus* (the condition in which there are rapidly recurring epileptic seizures), *status typhosus* (the typhoid state), and *status vertiginosus* (the condition of prolonged vertigo).

Status Lymphaticus.

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See also Lymphatic System, Physiology and Pathology (*Status Lymphaticus*); Thymus Gland.

Synonyms.—Lymphatism, Status Thymicus.

Definition.—A condition in which the thymus gland and lymphoid tissue generally are hypertrophied, associated with diminished powers of resistance to infections and injuries, and a liability to sudden death.

Historical.—For nearly a century medical literature has contained discussions as to the significance of an enlarged thymus. Its association with sudden death was noted as long ago as 1723 by Bichat, and the subject was brought into prominence by Kopp (1829). He believed that enlargement of the thymus caused a form of dyspnœa to which the name "thymic asthma" was given, and that this dyspnœa might prove fatal by direct pressure upon the trachea. Friedleben in his classical monograph of 1858 threw considerable doubt upon the relation of the thymus to dyspnœa or sudden death. He maintained that in many cases of so-called enlargement the gland was within normal limits, and that an enlarged thymus had no significance in cases of sudden death. These views prevailed in spite of the opposition of Virchow and Cohnheim, and the subject remained quiescent until 1888, when the work of Grawitz in Germany and Jacobi in America revived it. No doubt many of the patients supposed to suffer from thymic asthma in reality had laryngismus stridulus, and Jacobi pointed out that many cases of sudden death were due to laryngismus and had nothing to do with the thymus, but that there remained a residuum in which the thymus was the cause of the asphyxia. Rauchfuss, Baginsky, and others held similar views, and discussion became very active. Many theories based on clinical, anatomical, or experimental studies were advanced to explain the thymic death. New light was thrown on the subject by Paltauf, who in 1889 showed that the enlarged thymus constituted but one manifestation of an abnormal constitutional state, in which there was not only an enlarged thymus but also hyperplasia of the whole of the lymphoid apparatus. He found enlargement of the lymph glands in various parts of the body, the tonsils, lymph follicles at the base of the tongue and in the pharynx, the Malpighian bodies of the spleen, and the lymph follicles of the intestines. In some cases he described a hypoplasia of the heart and aorta similar to that described by Virchow in chlorotic subjects, so that in these cases Paltauf spoke of the chlorolymphatic constitution, and in older patients showing signs of this condition he found the blood picture of chlorosis. The views of Paltauf found acceptance but slowly; the evidence of late years, however, is strongly in their favour, and to-day lymphatism must rank as a clinical entity.

Etiology.—Little is known of the causes which predispose to this condition. We must remember that the lymphoid tissue in a child is in a state of unusual activity. There is much evidence that the lymphocytes play some part in nutrition, and it is a fact that any condition of ill-health in which nutrition is impaired tends to be accompanied by increased activity of the lymphoid tissue, showing itself in a hyperplasia of the organs in which such tissue is most abundant. This predominance of the lymphoid tissue usually declines at puberty but may persist afterwards, and such a case is marked by delicacy of health. Improper feeding and anything which induces malnutrition and diminishes the vitality of the tissues, such as infectious diseases in infancy, are possible factors in the causation of lymphatism. The frequent association with rickets also suggests that improper feeding has some influence.

No difference is observable in its incidence on the two sexes, and while most frequently found in childhood and adolescence it has several times been described in adults. Blake published 7 cases, only one of which was under twenty-seven, the oldest being in a man of fifty-five. In 20 cases studied by myself one was aged fifty, 3 were between twenty and thirty, 6 under twenty, and 10 under ten, the average age being twelve and a half years. It may occur as a family disease. Thus Hedinger mentions a family of nine children, five of whom died suddenly in infancy with signs of lymphatism; and several observers have recorded deaths under similar circumstances of from two to nine children in single families. In children it is often, but not invariably, associated with rickets. In adults an enlarged thymus is common, if not constant, in exophthalmic goitre. Ord and Mackenzie found an enlarged thymus in all their fatal cases, and since attention has been drawn to it the other signs of lymphatism have been found by other

observers, and it has been given as a cause of death in some cases of operation on exophthalmic goitre. Lymphatism has also been found in several cases of epilepsy (Ohlmacher).

Symptoms. — The condition is not usually diagnosed during life, but is found after the sudden death of its victims. Subjects have a pale, thin skin and pasty complexion. There is usually a good pad of subcutaneous fat. Signs of rickets often coexist. Physical development is retarded, and when older persons are affected they are undergrown and sexual development is late, the body retaining many infantile characteristics. Enlarged tonsils and adenoid vegetations in the pharynx are present, together with enlargement of the follicles at the base of the tongue. The superficial lymph glands of the neck, axillæ, and groins are enlarged, but not to any marked extent. The deeper glands — bronchial, mediastinal, and mesenteric—are also enlarged, but more difficult to detect during life. The glands are discrete, moderately firm, and show no tendency to fuse together or to break down. The blood *a priori* should show an increased lymphocytosis, and Ewing has described this in one case, a child of five who died under anæsthesia, and whose blood contained 76 per cent of lymphocytes. The blood taken post-mortem in several of my cases showed a marked lymphocytosis; and in 4 cases with every sign of the condition, examined during life, the blood showed respectively 8500 white cells with 52 per cent lymphocytes, 12,187 with 48 per cent lymphocytes, 10,000 with 43 per cent lymphocytes, and 14,067 with 34 per cent lymphocytes. All these children were between five and ten years of age, a period when the normal lymphocytosis of infancy should have disappeared. The blood in this condition needs further investigation, for if such a lymphocytosis be constant it will be an important diagnostic sign. The existence of an enlarged thymus may be shown by the presence of dulness on percussion over the upper part of the sternum. The normal area of thymus dulness even in young children should not extend much beyond the margins of the sternum. Dulness extending more than 1 cm. beyond the margin, above the second rib, shows in the absence of other causes an enlarged thymus. Simply engorged lymph glands, according to Blumenreich, who has made a careful study of thymus dulness in a large series of children, cause no dulness, while caseous glands do. When much enlarged the thymus can be felt in the suprasternal notch. Hochsinger has made a radiographic study of the thymus, and finds that when the shadow extends much to the left of the sternum the gland must be considered to be enlarged.

Some authors describe an increased excitability of the muscles and peripheral motor nerves, Trousseau's phenomenon and Chvostek's symptom being present. Gastro-intestinal trouble and catarrh of mucous membranes are frequent, and some of the children suffer from the "mucous disease" of Eustace Smith.

In the majority of cases symptoms distinctly referable to the lymphatism are absent, but in some the pressure of the enlarged thymus gives rise to respiratory troubles, classed under the general heading of "thymic asthma," a condition which has been confounded with laryngismus stridulus. Lange states that the paroxysm in thymic asthma differs from that in laryngismus in that regular sighing respiration is present throughout the attack in the former condition. In thymic asthma there is a dangerous progressive dyspnœa with stridor and cough occurring in paroxysms. In some instances the child dies in the first attack or series of attacks, whilst in others the condition may last for weeks or even years and finally terminate fatally if not relieved by operation. The cases in which the child dies during an acute attack after a few hours or even in the first attack are more common than the cases running a more protracted course. Some cases die with signs of suffocation and without definite asthmatic seizures. The child shows accelerated respiration, an access of suffocation, cyanosis, dilatation of the pupils, swelling of the veins of the neck, and death occurs in a few minutes. Laub has described a cerebral form of death from lymphatism. It usually occurs in young adults, and causes death in a few hours—twenty at the outside. The patient is attacked suddenly with coma or epileptiform convulsions. Sometimes cramp of the glottis occurs, or vomiting of a cerebral type. The post-mortem picture is the ordinary one of lymphatism with, in addition, cerebral œdema.

The majority of cases of lymphatism do not show signs of respiratory trouble, and the condition is not suspected till death occurs with startling suddenness. A number of cases, usually young infants, have been found dead in bed. The manner of death is naturally uncertain, but there are grounds for thinking that the infants are not perfectly well for a short time; sometimes they refuse food some hours before death, which probably takes place in a convulsive seizure. Nordmann and others have reported cases where sudden immersion in cold water was followed by instant death; possibly some of the deaths attributed to cramp may in reality be due to lymphatism. Trivial injuries and operations may cause sudden death: A son of Professor Langhans of Berlin died after a prophylactic dose of diphtheria antitoxin, and other similar cases are recorded. The prognosis of the acute infections is much more serious in these children than in normal children, in that sudden death may occur at any stage or during convalescence. Diphtheria is especially dangerous owing to its depressant nature.

True laryngismus stridulus may be fatal in these children.

Relation to Anæsthesia.—A certain number of the deaths under anæsthesia are due to lymphatism. They may occur at any stage of the administration, or after some hours have elapsed. When death occurs during anæsthesia the heart suddenly ceases to beat, the face becomes ashy pale, the pupils dilate, and after making a few noiseless, shallow inspiratory movements the child within one or two minutes is dead. Most observers agree that the heart fails before the respiration, and that death is from syncope. It is impossible to state how many of these patients pass through an anæsthesia without accident. It is known, however, that they may pass through one or two anæsthesias and succumb to a second or third. Chloroform is generally considered to be the most dangerous anæsthetic for these cases, and most deaths reported have been with this drug; but deaths have also occurred with the use of ether, A.C.E. mixtures, and ethyl chloride. Kundrat reported 10 deaths from chloroform in all of which lymphatism was present. Out of 3 cases reported by Blake, 2 were with nitrous oxide and ether and 1 with chloroform. In 8 cases investigated by myself the anæsthetic in each case was chloroform. When we consider what cases are particularly liable to death under anæsthetics it would seem that patients with goitre, either simple or exophthalmic, and patients with adenoids have given the most fatalities. When a child is suspected of suffering from lymphatism, and a general anæsthetic must be administered, ether or nitrous oxide should be preferred to chloroform or ethyl chloride. When difficulty occurs in the course of administration, the most rational treatment would seem to be direct stimulation of the heart by massage or electricity, and the injection of adrenalin solution or strychnine. Artificial respiration is probably of little value.

Medico-Legal.—In cases of sudden death in infants and young people, an enlarged thymus and the other signs of lymphatism found post-mortem are *prima facie* evidence of death from natural causes. A number of cases are on record where nursemaids or relatives have been charged with suffocating or fatally maltreating children, the true cause of death found at autopsy being lymphatism. Its importance in cases of death from injury, overlaying, and immersion in water will also be evident.

Morbid Anatomy.—The post-mortem appearances, broadly speaking, consist of a hyperplasia of the lymphoid tissue of the body. The degree and extent of this hyperplasia vary considerably. In all cases the thymus is enlarged. Dudgeon found the average weight in 16 cases to be 25 grammes; the largest, in a child of five months, being 47 grammes, the smallest 17 grammes. Of my twenty cases the largest gland weighed 35½ grammes, the smallest 17 grammes, the average being 24½ grammes. It may extend upwards to the lower border of the thyroid and downwards to the apex of the heart, completely covering the anterior surface of the pericardium like an apron. In appearance it is pale and swollen, and often contains a cavity in the centre from post-mortem degeneration. The cavity contains a milky fluid consisting entirely of leucocytes. Bacteriological examination is negative. Microscopical examination shows simply hyperplasia with an unusual number of eosinophile cells, particularly in the neighbourhood of the septa. In some cases only one or two groups of lymph glands may be enlarged, the most constant being those in the neighbourhood of the thymus and thyroid glands. In others the pharyngeal, thoracic, and abdominal glands are affected, with the axillary and inguinal glands to a less extent. Their minute structure shows nothing abnormal. The spleen is enlarged, firm, and dark red, with the Malpighian bodies standing out with unusual prominence. The intestines show enlarged Peyer's patches and solitary follicles, which may stand out like peas. The bone marrow is in a state of hyperplasia, and the yellow marrow of the long bones in young adults is replaced by red. The tonsils, with the pharyngeal and post-lingual follicles, are hypertrophied. The liver and kidneys frequently show fatty changes, and the heart is dilated and also often shows fatty changes. The hypoplasia of the heart and aorta described by Paltauf was not present in any of my cases, nor has it been found by other observers. The thyroid has frequently been reported as enlarged; but no special attention seems to have been paid to it, in spite of the frequent association of lymphatism with exophthalmic goitre. In all my 20 cases the thyroid was abnormal. In 10 it was markedly enlarged, 5 being operated on for goitre. In the remainder the gland was normal in size or only slightly enlarged, but in all microscopical examination showed marked changes. These changes consisted in a reduction or even absence of the colloid substance with hyperplasia of the cells, which grew into the alveoli in irregular masses, sometimes completely filling them. Some sections of these glands cannot be distinguished from sections of the thyroid from cases of exophthalmic goitre, although no symptoms of this disease were present during life.

Pathology.—Many theories have been advanced from time to time to account for the sudden death in these cases. They fall under two headings: (1) those which assume death to be due to direct pressure of the enlarged thymus upon the trachea or other vital structures, and (2) those which assume death to be due to toxæmia causing syncope.

It may be taken as proved that an enlarged

thymus is competent to produce, though rarely does produce, a dangerous and even fatal dyspnœa. Siegel's case illustrates this. A boy aged two and a half years had suffered from dyspnœa for four or five weeks. There was considerable stridor, with paroxysmal exacerbations in which the child seemed moribund from asphyxia. No laryngeal obstruction was found, and tracheotomy failed to give relief until a tube long enough to reach the bifurcation of the trachea was inserted. In a fortnight this was removed on account of pressure ulcers, and the symptoms returned as badly as before. A small area of dulness was detected over the upper part of the sternum, and enlarged thymus was diagnosed. Operation was determined upon. The anterior mediastinum was opened, and the thymus bulged into the wound; it was drawn up and sutured to the fascia over the sternum. This operation gave complete and permanent relief. Koenig, in a child of three months old who had suffered from dyspnœa from the second week after birth, extirpated part of the gland and sutured the rest to the sternum; while Panucker in a similar case extirpated the whole gland. Both operations gave complete relief. One difficulty in connection with this theory has been that in most cases direct evidence of compression of the trachea has been absent; but, as Paltauf points out, such pressure cannot be determined after death unless special precautions be taken. The upper part of the trachea must be dissected out and its anterior examined from above while the sternum and thymus are *in situ*. Beneke adopted this in two cases and found the trachea somewhat flattened, while if the head was bent backwards its lumen was entirely occluded. He thought that weakness of the neck muscles allowing the head to fall suddenly backwards was a fact—or to be considered. Lenbuscher also suggested that a sudden throwing back of the head might, by causing vascular congestion, so increase the degree of pressure as to produce asphyxia. Jacobi states that in an infant of eight months the distance between the sternum and vertebral column is 22 cm.—a space which might be completely filled by an enlarged and congested thymus. Jackson has placed the question beyond doubt by demonstrating with the bronchoscope the purely mechanical nature of thymic asthma. His patient, aged four, was wakened in the night with an attack of dyspnœa. The difficulty grew worse, and stridor came on. A radiograph showed an enlarged thymus. The trachea was opened under local anæsthesia, the thymus being seen to extend abnormally high in the neck. With the bronchoscope the trachea was seen to be compressed so that it measured not more than 2 mm. across on inspiration and 1 mm. on expiration. The mucosa was collapsed and came almost in contact across the lumen. A specially long cannula was inserted and worn for 4 weeks, giving complete relief. At the end of this time a second operation was performed. A curved incision was made just below the upper border of the sternum, the skin retracted upwards, and the incision carried down to the thymus, the sternal attachments of the sternomastoids being cut. The thymus bulged in the wound. Its attachments were broken down or ligatured and the gland removed. These manipulations were rendered possible by the use of a long tracheal cannula which prevented compression.

It is not difficult to understand sudden death in these cases, for we know how suddenly death comes in any form of tracheal stenosis with the lumen diminished to a mere chink. Slight engorgement from coughing or gagging during examination would be sufficient to cause temporary swelling and momentarily to shut off the passage of air. Once air is shut off the usual phenomena of asphyxia would occur and so engorge the thymus and vessels passing through the thoracic opening as to prolong the obliteration of the lumen until death ensued. Then recession of the blood and sagging of the viscera would allow the trachea to assume its normal shape post-mortem.

Other theories assume pressure on the large vessels causing death by fatal anæmia of the brain, or pressure upon the nerves (vagi or phrenics) or nerve plexuses and death reflexly or by direct paralysis of the heart. These theories at present have no anatomical support.

Those cases in which death is caused by direct pressure are few in number, and signs of the pressure are usually present in the form of chronic progressive dyspnœa before death occurs. Some authors regard these cases as distinct from cases of true lymphatism, but it is more reasonable to regard them as cases of lymphatism in which the hypertrophy of the thymus is unusually marked.

The typical mode of death in lymphatism is by syncope. Paltauf's views are rather indefinite; he believed that there is some underlying constitutional defect which lowers the resistance of the heart to disease or shock. Several attempts have been made to give this theory a definite basis, and Escherich voiced the view that the cause of death was a toxæmia resulting from abnormal function of the thymus. Many authors have assumed the existence of a true internal secretion of the thymus, but of this there is no proof. The thymus is not a ductless gland, but a localised mass of lymphoid tissue varying in size with other collections of similar tissue, and it is impossible to define cells which may be considered to act as secreting cells in the same sense as those of the thyroid or suprarenal. Swale Vincent has shown that extracts of thymus injected subcutaneously or intravenously have no specific effect. The same depressor effect occurs as with extracts of other

tissues—nervous, muscular, etc. Such secretions have been supposed to act by producing intravascular clotting (Spencer) or by action upon the vagi. Intravascular clotting has not been found by other observers. Blumer strongly supports the toxæmic theory, and regards lymphatism as the result of lymphotoxins. Flexner's work on lymphotoxins has shown that lesions somewhat resembling those of lymphatism can be produced experimentally in animals, but the organs in lymphatism do not show the necrotic and degenerative areas present in the experimental lesions.

A complete theory of lymphatism must account for the abnormal growth of lymphoid tissue, the changes in the bone marrow, the degeneration of the viscera, the constitutional disturbances, as well as for the sudden death. One of the most striking and constant changes in my series of cases was connected with the thyroid. It has long been known that lymphatism is often, if not invariably, associated with exophthalmic goitre, and indeed it has been suggested that lymphatism is a larval form of that disease. These changes have been described above; either they must be regarded as primary and the changes in the lymphoid tissue as secondary, or both are common results of some unknown toxin. In exophthalmic goitre, as Kocher has pointed out, there is constant swelling of the lymph glands in the neighbourhood of the thyroid, and an increase of lymphocytes in the blood even up to 60 per cent; and Nageli has shown that there are alterations in the bone marrow. We know that the abnormalities of thyroid secretion in exophthalmic goitre are attended by a risk of sudden death under certain conditions, such as anæsthesia; and it is plausible to think, in view of the constant changes in the thyroid, that sudden death in lymphatism has a similar origin. At any rate, in future investigations on lymphatism attention should be paid to the thyroid gland.

Treatment.—When these cases are diagnosed the children should be placed in proper hygienic surroundings and errors in diet corrected. Anæmia should be treated with iron, and gastro-intestinal troubles need attention. Procedures such as general anæsthesia, cold packs, cold bathing, likely to produce syncope must be avoided. In some cases the enlarged tonsils and adenoids have been removed without anæsthetics and improvement has followed, but such operation is not free from risk.

When urgent dyspnœa is present tracheotomy should be performed, and a long cannula extending nearly to the bifurcation of the trachea inserted. No patient should die of asphyxia from this cause if a surgeon is at hand with a long tracheal cannula. This can only be a temporary measure, and later the gland must be exposed and either drawn up and sutured to the sternum or completely extirpated. Seven cases of the latter operation have been reported with complete relief to the dyspnœa and no ill effects upon the nutrition or the blood. Friedlander has recently treated one case with the X-rays (five minutes every two or three days for ten applications). This produced a diminution in the size of the thymus and bronchial glands, relief of the dyspnœa, and considerable general improvement.

Status Thymicus. *See* Status Lymphaticus.

Statutory Nuisance.—A statutory is distinguished from a common nuisance as "something which either actually injures, or is likely to injure health, and admits of a remedy, either by the individual whose act or omission causes the nuisance, or by the local authority" (Wynter-Blyth); a *common* nuisance is "anything which worketh hurt, inconvenience, or damage to any one" (Blackstone).

Stavesacre. *See* Staphisagriæ Semina.

St. Catharine's Well. *See* Balneology (*America and Canada*).

Steam. *See* Larynx, Acute and Chronic Inflammations (*Treatment*); Balneology (*Vapour Baths*).

Steaming. *See* Invalid Feeding (*Preparation of Food, Steaming*).

Steapsin.—A ferment existing in the pancreatic secretion, and aiding in the saponification of fats. *See* Pancreas, Physiology of (*Chemistry*); Physiology, Food and Digestion (*Intestinal, Pancreatic Secretion, Lipase*).

Stearic Acid.—A fatty acid ($C_{18}H_{36}O_2$) from which the fat stearin ($C_{51}H_{110}O_6$) is produced. *See* Physiology, Tissues (*Fat Cells*).

Stearrhœa or Seborrhœa. *See* Skin, Diseases of Sweat and Sebaceous Glands (*Seborrhœa.*)

Steatopygia or Steatopyga.—An extraordinary degree of adiposity of the buttocks, seen especially in certain races, *e.g.* in the women of the Hottentots or Bushmen; spondylolysis (separation of the last lumbar vertebral body from the sacrum) may be associated with steatopyga.

Steatorrhœa.—An excessive amount of fat in the fæces (*see* Jaundice, Obstructive, *Symptoms*); also seborrhœa (*see* Stearrhœa).

Steel Wine.—Vinum Ferri. *See* Ferrum (*Metallic Iron*).

Stegomyia Fasciata.—The mosquito which is believed to carry the poison of yellow fever. *See* Yellow Fever (*Rôle of the Mosquito*).

Stellate Pelvis.—The compressed pelvis due to osteomalacia or to late rickets (pseudo-osteomalacic), so called on account of the stellate (star-like) shape of the brim.

Stellwag's Sign.—A physical sign found in some cases of exophthalmic goitre, and consisting in diminution in the frequency of the winking movements of the upper eyelids with an unusually wide palpebral aperture. *See* Thyroid Gland, Medical (*Exophthalmic Goitre*).

Steno-.—In compound words *steno-* (Gr. στένος, narrow) means narrow or contracted.

Stenocardia.—Angina pectoris or breast-pang. *See* Angina.

Stenocephaly.—Narrowness of the head in one or other diameter or in several.

Stenon's Duct. *See* Stensen's Duct.

Stenosis.—A narrowing or constriction of any part, especially of such parts as the aortic orifice, the pylorus, or the cervix uteri. *See* Gastro-Intestinal Disorders of Infancy (*Diseases of the Stomach, Congenital Hypertrophy of the Pylorus*); Heart, Myocardium and Endocardium (*Pulmonary and Tricuspid Stenosis*); Heart, Myocardium and Endocardium (*Physical Signs, Aortic and Mitral Stenosis*); Larynx, Affections of the Cartilages (*Stenosis*); Menstruation and its Disorders (*Retention of the Menses, Causes*).

Stensen's Duct.—The duct of the parotid gland, named after Nicolaus Stenon or Niels Stensen, a Danish anatomist of the seventeenth century (1636-1686). *See* Parotid Gland, Disorders of (*Anatomy*).

Stephanion.—A craniometric point situated where the temporal crest, after passing over the frontal bone, crosses the coronal suture and passes on to the parietal.

Steppage Gait.—A peculiar mode of walking (high-stepping) seen in locomotor ataxia, in alcoholic multiple neuritis, etc.

Steppe Disease.—Rinderpest.

Stercobilin.—A pigment (hydrobilirubin) found sometimes in fæces. *See* Fæces (*Chemical Examination*).

Stercoraceous.—Fæcal or resembling fæces (Lat. *stercus*, dung or ordure); *e.g.* stercoraceous vomiting, as in intestinal obstruction. *See* Intestines, Surgical Affections of (*Obstruction, Diagnosis*).

Stercoremia.—A depraved state of the blood due to the retention of fæces in the bowel.

Stereo-.—In compound words *stereo-* (Gr. στερέος, solid) means solid or relating to solids (tridimensional forms); e.g. *stereogastrula* (a solid gastrula), and *stereotypy* ("morbid persistence of a volitional impulse when once started" (Gould)).

Stereognostic Sense. *See* Syringomyelia (*Symptoms*).

Stereoscope.—An instrument by means of which two similar (but not identical) pictures of the same object are so presented to the eye as to give the appearance of solidity and relief; it is used in the treatment of squinting (*see* Strabismus, *Orthoptic Treatment*) and as a means of teaching anatomy, etc.

Sterigmæ. *See* Micro-Organisms (*Hyphomycetes*).

Sterilisation and Sterilisers. *See* Aseptic Treatment of Wounds (*Disinfection of Instruments*, etc.); Infant Feeding (*Artificial, Sterilisation*); Milk (*Dietetic, Sterilised*); New-born Infant (*Feeding, Artificial*).

Sterility.

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Sterility is the incapacity on the part of a man to beget a child, or on the part of a woman to conceive. The word is sometimes more vaguely employed; thus a woman who has borne no children after several years of married life is said to be sterile. She, however, may be potentially fertile, her husband being responsible for her not conceiving, either because he is sterile, or because he is impotent. For the definition of these conditions, and for the consideration of the general subject of sterility in the male, the reader is referred to the article on "The Testicle."

Etiology.—It will be conductive to clearness if we remember that conception depends upon four factors.

On the part of the female:—

A. The production of healthy ova.

B. The possession of a healthy patent channel of communication between the vulva and the ovary.

On the part of the male:—

C. The production of healthy spermatozoa.

D. The effectual deposition of spermatozoa in the female genital passages.

We are not here concerned with the last two

factors, the failure of which constitute male sterility and impotence respectively.

Sterility in women depends, then, on one of two principal conditions.

A. Defective ovulation, or the non-production of healthy ova.

B. Defective conditions of the genital passages.

We must consider each of these conditions in detail.

A. Defective Ovulation, or the Non-Production of Healthy Ova.—By a "healthy" ovum we here understand one that is capable of fertilisation and subsequent development; for there is reason to think that a form of imperfect ovulation may occur in childhood.

Defective ovulation may be due, in the first place, to immaturity (before puberty), or to senility (after the menopause). During the usual reproductive period, extending commonly from the age of fifteen to that of forty-five, defective ovulation may be due to absence or under-development of the ovaries, to ovarian disease, or to certain constitutional conditions.

1. *The absence of ovaries* is very rare. When this condition is present it is usually associated with some gross malformation in the body generally. If there be no such malformation, the woman who has no ovaries retains the physical and often the mental characteristics of the child.

2. *Under-development of the ovaries* is not so rare as the preceding condition. All gradations are possible, from ovaries that retain their infantile size and shape, and present the form of narrow, elongated glands, to those that are merely under-sized, but otherwise present an appearance closely similar to that of ordinary ovaries. A corresponding gradation is observed in the physical development of these patients. On the one hand we see a type in which the woman resembles a child in all but stature, with flat, childish breasts, no pubic hair, small external genitals, and total absence of menstruation. On the other hand, the woman may be to all appearances well developed—the vulva being normal, the pubes covered with hair, and the breasts rounded. Menstruation may then be present, but it starts late, and is irregular and scanty; and the menopause supervenes earlier than usual. Under-developed ovaries are nearly always associated with incomplete uterine development; thus the uterus may retain the preponderance in the length of the cervix that is found in early life; or it may show a marked diminution in size, the body and cervix being nevertheless of normal relative length. The uterine canal varies in length from one to two inches. The vagina is usually small, but it may be sufficiently developed to admit of intercourse, so that the condition is not suspected.

Prognosis is hopeless, since sterility is irrevocable.

Treatment is consequently *nil.*

3. *Ovarian Disease.*—Certain new growths of the ovary, multilocular cysts, dermoids, and solid tumours, and certain inflammatory conditions, such as ovarian abscess, so disorganise the ovarian tissue that healthy ovulation cannot take place. If both ovaries be affected, sterility results.

Treatment, which resolves itself into ovariotomy, is undertaken on general grounds, and not with any hope of curing the sterility, which is irremediable.

4. *Defective Ovulation due to Constitutional Conditions.* — It is sometimes found that a woman who appears to have all her organs healthy and well developed nevertheless does not conceive (it is premised that in such a case the fault does not lie with the husband). We must then assume that she is the subject of defective ovulation, due to constitutional conditions whose nature is obscure, though they are probably dependent on faulty metabolism. Sometimes such patients are very thin, even emaciated; more frequently they tend to obesity. Alcoholism and the morphia habit are well known to have a prejudicial effect on the function of ovulation. It appears in some cases that the reproductive powers have become exhausted; for the patient may have borne a child within a year or two of marriage, and may have remained childless thereafter. It is possible that masturbation may exhaust the reproductive power comparatively early. In this connection we may mention the view that sterility may be due to some want of "affinity" between husband and wife; in support of this view cases are quoted in which after years of childless marriage a man and wife are divorced, and each becomes a parent when married again.

Prognosis.—In many of these cases, all that can be said is that there is no evident reason why the patient should not become pregnant; and no more definite prognosis than this should be given.

Treatment.—The duty of the medical attendant will chiefly consist in prescribing a hygienic mode of life. If there be reason to suppose that intercourse is indulged in too frequently, it is well to enjoin total abstinence for a time; this is best secured by advising that the patient should spend some weeks, preferably with friends, in the country or by the seaside; for the hygienic conditions can then be obtained at the same time.

B. Defective Conditions of the Genital Passages.—The genital passages may be responsible for sterility owing to obstruction in some portion of them, or to an unhealthy condition of the lining membranes, or to some other unfavourable condition. These faults must be considered in detail.

1. *Defects of Patency.*—It is obvious that closure of any part of the passage from the

vulva to the ovary must cause sterility. Such closure may be congenital, taking the form of atresia of the vaginal orifice, or absence of some part of the vagina; or it may be secondary, involving the os externum or internum, or the uterine or abdominal ostium of the Fallopian tube.

(*a*) *Atresia Vaginalis.* — Any part of the vagina may be the seat of an obstruction, but this is found much the most frequently at the vaginal orifice, where the condition is sometimes described as "imperforate hymen," or atresia hymenalis. It has been shown that the hymen in such cases is not usually imperforate, and that this structure can generally be recognised adherent to the outer surface of the obstructing membrane. After puberty vaginal atresia causes retention of menstrual products in the form of hæmatocolpos, and, later on, of hæmatometra. When the obstruction is near the uterine end of the vagina coitus is possible; but sterility necessarily results, because the spermatozoa cannot reach the uterus. When the atresia affects the lower part of the vagina no sexual intercourse can take place.

Treatment consists in incising the obstructing membrane or septum, and excising the part or the whole of it when possible. This at any rate allows of intercourse taking place; but it is very doubtful whether pregnancy ever follows in a patient who has once been the subject of hæmatocolpos and hæmatometra. We have not met with a record of pregnancy under these conditions. Sterility is to be expected because, in the first place, atresia vaginalis is not infrequently associated with under-development in other parts of the genital organs; and in the second place, the uterine mucosa is so altered by the existence of hæmatometra that it is very doubtful whether it would permit of the development of the oösperm, even if fertilisation itself occurred.

(*b*) *Absence of a Part of the Vagina.*—Considerable variations are met with as to the extent of vaginal deficiency; and all gradations may exist, from the condition in which only a short portion of vagina is absent to that in which practically the whole of it is replaced by a fibrous cord.

What has just been said as to the probability of sterility after restoration of the patency of the vaginal canal applies with even greater force to cases in which a part of the vagina is absent. For although an artificial vagina may be made surgically, it is usually very unsatisfactory for the purpose of intercourse, and almost always useless as far as impregnation is concerned.

(*c*) *Atresia of the Os Internum and Externum.* —Such atresia may theoretically be of congenital origin; but in practice it is nearly always met with as a secondary closure following inflammatory conditions or the application of strong caustics to the cervix. Hæmatometra results, and the retained products may become septic, so that the uterus is converted into a bag of pus (pyometra). This is especially apt to occur in cases of carcinoma of the cervix.

Treatment.—It is necessary in any case to overcome the obstruction and restore the patency of the cervical canal, in order that menstruation may be carried on; or, in cases of pyometra, for the purpose of evacuating the pus. The prognosis in relation to sterility is, however, almost hopeless, because the pathological changes caused by the previous inflammation or disease are prohibitive of conception taking place.

(*d*) *Atresia of the Uterine or Abdominal Ostium of the Fallopian Tube.*—Purulent salpingitis, whether due to gonorrhœa, to tuberculosis, or to sepsis, results almost invariably in complete closure of the abdominal orifice of the tube by a sealing-up process. The uterine orifice is not so often closed in this way, but the patency of the uterine end of the tube suffers from infiltration of the tubal wall with inflammatory products, and from the doubling up of the tube on itself. Most cases of this kind are due to gonorrhœal infection, and the result is permanent sterility. This is necessarily the case as long as the abdominal orifice remains occluded; and in many instances the health and even the life of the patient demand the removal of the pus-tubes and ovaries. Sterility is then confirmed. In a few cases, when the tube has not been too far disorganised, it has been found possible to make an artificial ostium to the tube; and pregnancy has been known to follow this procedure. But it is obvious that prognosis in relation to a future pregnancy is very bad.

Treatment.—We cannot enter here in detail into the treatment of tubal disease, for the subject is a large one, and each case requires to be dealt with on its merits according to the methods described in text-books. It is sufficient to say that there are cases in which it would be right to attempt to restore the function of the tubes by a conservative operation.

2. *Defects due to Inflammation of the Lining Membrane.*—All the conditions described so far present two features in common: in the first place, they are the cause of inevitable sterility if left untreated; in the second place, treatment is either entirely or relatively hopeless.

The defects to be considered in this section are not an insuperable bar to pregnancy, since this may occur in spite of them; and proper treatment holds out a fair prospect of the cure of the sterility. We have here to deal with vaginitis, endometritis, and salpingitis.

(*a*) *A slight vaginitis* is of little or no consequence; but a severer type will prevent conception, owing to the injurious effect of the pathological secretions on the vitality of the spermatozoa. Moreover, vaginitis will usually cause dyspareunia, with the result that intercourse does not take place.

(*b*) *Endometritis* causes sterility in two ways: in the first place, the secretions act in the same way as in vaginitis, and the spermatozoa are thus prevented from reaching the ovum; in the second place, should the spermatozoa succeed in running the gauntlet, and fertilisation take place, the fertilised ovum or oösperm will be unable to become attached to the unhealthy mucosa, and even if it succeed in doing this it will be prematurely cast off as in abortion.

(*c*) *The influence of salpingitis*, when this is not sufficiently intense to seal up the ostium tubæ, is more difficult to predicate. Theoretically it would act in three ways: the passage of the spermatozoa would be hindered (in cases in which fertilisation would otherwise occur in the tube); the progress of the ovum towards the uterus would be checked; and, if fertilisation did occur, the normal descent of the oösperm towards the uterus would be impeded. Under these circumstances either the oösperm would perish, or tubal pregnancy might result.

Prognosis is more favourable in this class of case than it is when the sterility is due to other causes, because the inflammatory conditions can be cured in the majority of cases.

Treatment.—With mild forms of inflammation of the vagina, uterus, and tubes, the treatment consists of rest in bed, douches, the use of glycerine tampons, and temporary abstinence from intercourse. When endometritis is more severe, or has become chronic, curetting gives the best results.

3. *Defects of Structure of the Uterus.*—Congenital under-development of the uterus, hyperplasia and new growths, and premature atrophy, are found associated with sterility.

(*a*) *Congenital Under-development.*—All gradations are met with, from an absolutely defective, rudimentary, or malformed uterus, to one that is only a little under normal size. The extreme forms are usually associated with defective development of the ovaries. Kleinwächter[1] has made an interesting analysis of the conditions found in 648 cases of sterility met with in his practice. Those that come under the present heading numbered 214, or 33 per cent. They may be tabulated as follows:—

Defective, rudimentary, and malformed uterus	15 cases	= 2·3 %
Under-developed uterus	116 ,,	= 17·9 ,,
1. Hypoplastic uterus (71)— (*a*) Extreme forms, 14; (*b*) Medium degrees, 22; (*c*) Transition forms to normal, 35.		
2. Infantile uterus (45)— (*a*) Fœtal, 6; (*b*) Infantile, 13; (*c*) Transition, 26.		
Conical elongated vaginal portion	47 ,,	= 7·3 ,,
Stenosis of os externum	36 ,,	= 5·5 ,,
Total	214 ,,	= 33 ,,

[1] *Ein Betrag zur Lehre der Sterilität.*

The more extreme degrees of under-development necessarily produce sterility; in the case of transition forms, conical cervix, and stenosis of the os externum, the bar to conception is not an absolute one.

Prognosis is in no case very good; but it will vary with the degree of under-development. The nearer the approach to normal the better the prognosis.

Treatment is useless in extreme cases. In those cases in which we have said that the bar to conception is not absolute, success sometimes follows dilatation of the cervical canal.

(*b*) *Hyperplasia and New Growths of the Uterus.*—Among new growths we must specially mention fibromyomata. These conditions are often found associated with sterility, but it is doubtful what part they play as causal factors: it is certain that pregnancy may occur in cases of fibromyomata. Kleinwächter found these tumours in 32 of his cases, or 5 per cent. A hyperplastic uterus was present in 5 cases.

Treatment.—Hyperplasia requires to be dealt with by curetting, followed by the use of douches and tampons. When myomata are present sterility is desirable rather than otherwise, since the complication of these tumours with pregnancy is fraught with grave risk to the patient.

(*c*) *Premature atrophy of the uterus* is found associated with primary sterility as effect rather than as cause. But after one or two pregnancies a relative sterility may be produced by atrophy of the uterus, which may take place soon after a pregnancy, when it is described as superinvolution.

There is no cure for sterility associated with atrophy.

4. *Defects of Position of the Uterus.*—In Kleinwächter's series 82 cases, or 12·5 per cent, showed backward or lateral displacement of the uterus. Here again we must make a distinction between associated and causal conditions. For, in the first place, with the displacement may be present other pathological conditions, such as endometritis and diseased appendages, which have more to do with the sterility than the displacement has; and in the second place, it must be remembered that conception sometimes occurs when the uterus is retroverted. There is, however, a residue of cases in which the displacement is in itself an obstacle to conception.

Treatment consists in replacing the uterus, and keeping it in position with a properly fitting pessary; if patient and repeated trials with pessaries be ineffectual, ventrofixation of the uterus is indicated.

5. *Functional Defects.*—Under this heading we may consider conditions which lead to sterility by preventing intercourse, although no anatomical cause for sterility is present. These include vaginismus, that is, a spasmodic, painful

contraction of the vaginal muscles when intercourse is attempted, rigidity of the hymen, mere smallness of the vagina, nervousness, or any other conditions which make coitus physically or mentally painful.

Treatment.—In many cases both dyspareunia and sterility may be cured by dilatation of the vaginal orifice under an anæsthetic.

The above etiological factors in the production of sterility in woman may be summed up in tabular form as follows:—

A. *Defective Ovulation*, due to—

(1) Absence of the ovaries: (2) Under-development of the ovaries; (3) Ovarian disease; (4) Constitutional causes; (5) Immaturity and senility.

B. *Defective Conditions of the Genital Passages*—

(1) Defects of patency: (*a*) Atresia vaginæ; (*b*) Absence of the vagina; (*c*) Atresia of the os uteri internum or externum; (*d*) Atresia of the ostium tubæ.

(2) Defects of the membrane lining the passages: (*a*) Vaginitis; (*b*) Endometritis; (*c*) Salpingitis.

(3) Defects of structure of the uterus: (*a*) Congenital under-development; (*b*) Hyperplasia and tumours; (*c*) Atrophy.

(4) Defects of position of the uterus.

(5) Functional defects.

Diagnosis.—In the investigation of a case of sterility with a view to determining what is its cause, and whether it can be cured, the history should first be inquired into. The principal points to ascertain are—the character of menstruation and the age of its onset; the existence of dyspareunia and the presence or absence of normal sexual feelings and desire; and the existence or not of gonorrhœa and syphilis at any period of the married life. If menstruation has come on very late, and has continued scanty and irregular, we shall be prepared to find some degree of under-development; dyspareunia and the absence of normal sexual feelings may mean that coitus has never been properly consummated; a history of syphilis will lead one to suspect endometritis; whilst a previous gonorrhœa will probably have left behind it endometritis or damaged tubes. It will be observed that nearly all the causes of sterility enumerated in the preceding table fall under one of the three categories foreshadowed in the history of the case, namely:—Under-development or primary sterility; pelvic inflammation or acquired sterility; incomplete sexual intercourse or apparent sterility.

We must next investigate the general health and note the general development, and then proceed to the examination of the pelvic organs. A childish appearance, combined with defective breasts and scanty pubic hair, often points to under-development of the genital organs; and this may be further indicated by smallness and immaturity of the vulva, or by a small or deficient vagina. If, in addition, the uterus is small, with a cavity not exceeding two inches in length, we are justified in the conclusion that sterility is primary and irremediable. In such a case the ovaries will probably be also small.

If we find no evidence of under-development, the condition of the pelvic organs must be investigated with a view to determining whether any inflammatory disease exists or has existed. Cervical erosion, or a heavy uterus with abundant leucorrhœa, will point to endometritis; thickened tubes will indicate salpingitis of varying degrees. Under these circumstances we have to do with an acquired sterility, which is probably incurable if the tubes are damaged, but curable if the endometrium alone is at fault. On the other hand, the only pathological condition present may be a backward displacement, or a long conical cervix with stenosis of the os externum; these conditions may be the cause of the sterility, or they may be only incidental and devoid of etiological importance; we cannot tell their precise rôle till the effect of treatment has been tried. Lastly, we may find some cause for dyspareunia, such as vaginismus, painful caruncles of the hymen or urethra, or prolapsed and tender ovaries.

If we find the pelvic organs to all appearance normal, we must conclude that we have to do with one of three things: first, that it is a case of defective ovulation; secondly, that the blame for the sterility lies with the husband; thirdly, that intercourse has not been effectively accomplished. Suitable inquiry may clear up the last point; the second will be cleared up by examination of the husband; and if neither of these two account for the sterility, we are reduced by exclusion to the first, and we may have to tell the patient that there is no obvious reason for her sterility.

Treatment. — The treatment of individual conditions has already been briefly referred to, and we may now shortly review the whole subject. In the first place, marked under-development of the uterus or ovaries precludes any treatment, and the patient must reconcile herself to her condition. Extensive pelvic inflammation and tumours of the uterus or appendages will require treatment on their own account, and the result as regards sterility is a secondary matter. For endometritis a thorough curettage is required, both for its own sake and because this will give the best prospect of subsequent conception; backward displacements of the uterus require appropriate treatment on the same grounds. Conical cervix with stenosis of the os externum should be treated by dilatation, inasmuch as this will give the best chance of pregnancy. Any conditions causing dyspareunia must receive proper attention. With normal pelvic organs, we can only prescribe medicinal

treatment if the general health is at fault, and enjoin a period of abstinence.

We must here remark that when we find only some condition of doubtful influence in the causation of sterility, the husband should be examined before any treatment is carried out on the wife. "It is a too common assumption that in cases of sterility the fault is on the side of the woman. In 250 cases in which notes are given by Brothers,[1] information concerning the condition of the husband was obtained in 72 instances, with the result that 50 of them were shown to be responsible for the sterility of their wives. The cases in which the condition of the man was inquired into were those in which no cause of sterility was found in the woman. In 12 cases nothing abnormal could be found in either husband or wife. Thus of all the cases of sterility one in every five was attributable to the husband. This is a point to be borne in mind when the practitioner is consulted for this cause, for otherwise minor operations, such as dilatation and curetting, may be performed unnecessarily. Brothers records that 14 women had been treated by sounds, dilators, pessaries, etc., when the semen of the husband did not contain a single spermatozoon."[2]

The natural aspiration of a healthy woman is to be a mother; and sterility is to many a cause of lifelong unhappiness. Some of this unhappiness may be removed by proper treatment. Thus in 70 cases Brothers was able to trace the results of treatment, and of these 12 per cent became pregnant. The percentage of results in other cases has been even higher. It is therefore reasonable to urge that every case of sterility should receive careful investigation, followed by suitable treatment, and that those women who crave for the high boon of motherhood should not be merely met with an attitude of unmasterly inactivity.

Sternal.—Belonging to the sternum or breast-bone; *e.g.* the sternal angle, the sternal glands. *See* Lymphatic System, Physiology and Pathology (*Table of Glands, Thorax*).

Sternalis Muscle. — An occasional muscle, found perhaps rather more frequently in anencephalic fœtuses, lying parallel to the sternum on the origin of the pectoralis major; it may be regarded as a relic of the panniculus carnosus.

Sternberg's Disease. — A form of pseudo-leukæmia, tuberculous in nature.

Sternebra. — One of the segments of which the sternum is composed.

Sterno-—In compound words *sterno-* (Gr. στέρνον, the breast) means relating to the sternum or breast-bone; e.g. *sterno-cleido-mastoid* (relating to the sternum, the clavicle, and the mastoid process of the temporal bone), *sterno-costal* (relating to the sternum and the ribs), *sternodynia* (pain in the sternum), *sterno-hyoid* (relating to the sternum and hyoid bone), etc.

[1] *The Post-Graduate*, February 1901.
[2] Giles, article "Sterility," *Medical Annual* for 1902.

Sterno-Clavicular Joint.

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See also Joints, Diseases of (*Synovitis, Hydrops*, etc.).

This joint is subject to different forms of injury and disease, although to a lesser degree than most other articulations. The most common surgical affection is dislocation. In the order of frequency, the displacement is (*a*) forwards, (*b*) backwards, and (*c*) upwards. The accident is usually brought about by violence applied to the outer end of the clavicle, *e.g.* by a fall or blow on the front of the shoulder, which displaces the sternal end forwards. The backward dislocation is more commonly induced by direct violence, which drives the sternal end of the clavicle backwards. The rarest dislocation is the upward one, which may be induced by violence acting on the outer end of the clavicle from above, whereby the shoulder is forced downwards and inwards. A case has been recorded where spontaneous displacement in a forward direction occurred in a weak subject from muscular exertion. Dislocations occur in this joint as a sequel to a chronic tuberculous or other diseased process in the joint.

The frequency with which the forward displacement occurs is explained by the relative weakness of the anterior sterno-clavicular ligament. As the posterior ligament is stronger, dislocation backwards is less frequent. Further, the fibres of the rhomboid ligament on the posterior aspect of the joint are not easily ruptured, and they are a powerful preventive against either the posterior or upward dislocation.

Clinical Features.—The clinical features will vary according to the completeness of the dislocations. In the *forward* dislocation the diagnosis is readily determined by the marked projection anteriorly, recognisable without difficulty as the articular end of the clavicle. If it be necessary, the diagnosis can be confirmed by various movements; *e.g.*, if the elbow be raised, the projection is depressed, and if the shoulder be raised and thrown forwards, the prominence tends to disappear. The clavicular tendon of the sterno-mastoid is prominent, and the patient's head is inclined towards the affected side. The possibility of the condition being mistaken for a fracture near the sternal end of the bone should be borne in mind.

Treatment.—The reduction is easy, but its maintenance is attended with much difficulty. The most satisfactory method is by the patient

resting on a couch for four to six weeks with the arm in a sling, and the application of direct pressure on the part by a woollen pad. In many cases it is found impracticable to carry out this treatment, and it is fortunate that little harm results even if the joint be left permanently displaced.

The *backward* dislocation is characterised by a marked depression at the root of the neck, and the head of the bone is recognised to lie in an abnormal position, if the contour of the bone be traced from without inwards. There may be pressure on the œsophagus or trachea, and disturbance of the circulation from local obstruction of important vessels. In treatment the shoulders should be bandaged well backwards, using a cushion fixed between the shoulders posteriorly.

In the *upward* dislocation the head of the bone rests on the top of the sternum. The sternal portion of the sterno-mastoid is prominent, while the clavicular portion is relaxed. In treatment the usual difficulty is experienced in keeping the bone in position. Reduction should be effected by drawing the shoulder well outwards, and at the same time make pressure on the shaft of the clavicle from above.

Diseases of the Joint.—The ordinary forms of synovitis of the sterno-clavicular articulation are very rare, but suppurative forms of inflammation are met with in the course of septicæmia or pyæmia. The diagnosis of a *pyæmic joint affection* has to be made from the general condition. Locally the presence of swelling and redness of the skin over it, with œdema, are characteristic symptoms, and with these symptoms are associated inability to raise the arm to the horizontal position. As a rule, however, the symptoms produced by this local condition of the sterno-clavicular joint are marked by the general constitutional symptoms of the septicæmia. The treatment should be directed mainly to the general condition. The local affection may demand treatment by early and free incision, with evacuation of the effusion. Thorough drainage is essential to prevent backward extension of the purulent effusion into the structures at the root of the neck, or its downward extension into the mediastinum. The structural changes induced in the joint by a pyæmic invasion are characteristic. They include acute ulceration and destruction of the cartilage and other soft structures of the joint. As a general rule, the prognosis is highly unfavourable.

Chronic rheumatic arthritis frequently affects the sterno-clavicular joint. It is characterised by a nodular enlargement of the joint structures, and there may be creaking in the joint on movement. Movements at the shoulder joint are accompanied by sharp pains at the sternal end of the clavicle, the pains being sometimes of a shooting character, and radiating upwards and backwards along the side of the neck. The etiology and pathology of this affection have already been discussed in the article on "Chronic Rheumatism" (vol. viii.). In that article the opinion was expressed that this disease may really be an attenuated pyogenic infection of the joint structures. The treatment should be conducted along the lines laid down in the article on "Rheumatism."

Tuberculous disease is occasionally met with in the sterno-clavicular joint, but this is one of the joints least frequently involved. The tuberculous process may start in the articular end of the bone, or in the synovial membrane, and spreads and involves the other structures of the joint. The clinical features are similar to those seen in tuberculous affections elsewhere, and are mainly distinguished by their "quiet" nature.

Chronic suppuration in the vicinity of the joint is present in many of the cases. Treatment should be conducted on the lines suitable for tuberculosis in general. It may be necessary to open the joint freely, and scrape the articular ends of the bone.

A *neurotrophic joint lesion* is sometimes met with in the sterno-clavicular articulation. This is especially seen in cases of syringomyelia (*q.v.*). This lesion is characterised mainly by unnatural relaxation of the soft structures of the articulation, which allows of unnatural movement at the joint. As in other joint lesions in syringomyelia, it is the joints of the upper extremity that are most prone to be affected. The diagnosis is to be made from a general survey of the clinical features of the case, and especially from the peculiar sensory disturbances that are characteristic of this disease.

Sterno-Mastoid. — Relating to the sternum and to the mastoid process of the temporal bone, *e.g.* the *sterno-mastoid muscle.* *See* Brain, Physiology of (*Spinal Accessory Nerve*); Labour, Diagnosis and Mechanism (*Podalic Lies, Injuries of Child's Neck*); Neck, Region of (*Sterno-mastoid Tumour*); New-born Infant (*Hœmatoma of Sterno-mastoid Muscle*); Spasm (*Cramp, Wry-Neck*); Spinal Accessory Nerve; Wry-Neck or Torticollis.

Sternopagus.—A teratological type of fused twins in which one infant is united to the other in the sternal region. *See* Teratology (*Thoracopagous Double Terata*).

Sternoschisis.—Fissure of the sternum as in the man E. A. Groux.

Sternum. *See* Chest, Deformities of (*Congenital*); Chest, Injuries of (*Ribs and Sternum*); Heart, Myocardium and Endocardium (*Symptomatology, Dropsy over Sternum*); Pulse (*Auricular Pulsation in a Case of Cleft Sternum*); Scurvy, Infantile (*Clinical Features,*

Depression of Sternum); TERATOLOGY (*Malformations of Thorax*).

Sternutatory.—Producing sneezing or sternutation; errhine; *e.g.* tobacco in the form of snuff, ipecacuanha, and sassy bark. *See* PRESCRIBING (*Action on Mucous Membranes*).

Stertor.—Deep respiration accompanied by a snoring sound; met with in cases of apoplexy, etc. *See* BRAIN, AFFECTION OF BLOOD-VESSELS (*Cerebral Hæmorrhage, Diagnosis*).

Stetho-.—In compound words *stetho-* (Gr. στῆθος, the breast or chest) means relating to the thorax; e.g. *stethograph* (an instrument for recording the movements of the chest), *stethomenia* (vicarious menstruation from the bronchi), *stethomitis* (inflammation of the muscles of the chest), etc.

Stethoscope.—An instrument, with a single or a double ear-piece, by which auscultation of the thoracic or (sometimes) the abdominal organs is carried out. *See* CHEST, CLINICAL INVESTIGATION OF (*Auscultation*). *See also Cross References* under AUSCULTATION.

Stevenson's Screen.—A roofed and louvred box for sheltering shade thermometers in. *See* METEOROLOGY (*Temperature*).

Stewart's Method.—A plan for estimating the organic nitrogen in the soil, devised by Hunter Stewart.

Stewing. *See* INVALID FEEDING (*Preparation of Meats, Stewing*).

St. Gervais. *See* BALNEOLOGY (*France, Sulphated Muriated Waters*).

Sthenic Fever.—Fever characterised by a high temperature and a full, quick pulse (Gr. σθένος, power or strength).

Stibium. *See* ANTIMONY.

Sticking Plaster. *See* PLASTER.

Stiff Joint. *See* JOINTS, DISEASES OF, (*Anchylosis*).

Stiffneck. *See* RHEUMATISM, CHRONIC (*Muscular*).

Stiffneck Fever. *See* MENINGITIS, EPIDEMIC CEREBRO-SPINAL.

Stigma.—A small mark, cicatrix, or spot, commonly used in the plural (*stigmata*) for the hæmorrhagic spots seen in hysteria in the positions occupied by the nail-wounds inflicted in crucifixion; the physical stigmata of heredity are malformations (usually of the minor type) commonly found in criminals and the insane (*e.g.* abnormalities of the external ear, etc.). *See* HYSTERIA (*Symptoms, Stigmata*); MENTAL DEFICIENCY (*Diagnosis, Stigmata of Degeneration*).

Still Birth. *See* NEW-BORN INFANT (*Asphyxia Neonatorum*). *See also* ASPHYXIA (*In New-born Infants*); LABOUR, ACCIDENTAL COMPLICATIONS (*Injuries to Fœtus, Still-birth*); MEDICINE, FORENSIC (*Infanticide*).

Stillicidium.—The flow of a liquid slowly, drop by drop, or *guttatim*. *See also* BALNEOLOGY (*Douche Bath*).

Stilling's Canal.—The central canal of the spinal cord, also the hyaloid canal.

Stilling's Nucleus.—The red nucleus of the subthalamic region; the sacral nucleus of Stilling is an island of nerve cells in the sacral region of the spinal cord. *See* SPINAL CORD, MEDICAL (*Anatomical Considerations*).

Stimulants. *See* ALCOHOL (*Clinical Uses*).

Stimulus. *See* PHYSIOLOGY, PROTOPLASM, CELL (*Stimuli*); PHYSIOLOGY, TISSUES (*Muscle and Nerve Stimulation*).

Stinging Insects.—Many insects when in a mature stage bite the skin of man in order to obtain nutriment, and all, whilst doing so, probably inject into the skin with the saliva a toxic substance—probably formic acid in the case of the bee sting—which inhibits coagulation or promotes the flow of blood. The sting may be trivial or may result in serious disease or even death, according in part to the species of insect and in part to the idiosyncrasy of the person who has been stung.

One of the most frequent insects which in this way attacks man is *Pulex irritans*, the common flea. The lesion is a small circular red area with a central spot of darker tint. When the lesions are petechial, the case may be mistaken for purpura. In other persons there may be urticaria or a more or less general erythema, and there is much cutaneous irritability. The rôle of the pulex as a transmitter of plague infection has of late engaged the attention of many investigators.

The lesion caused by the bed bug (*Cimex lectularius*) is a whitish wheal with a central spot, and much itching. Some persons manifest hardly any signs of reaction to the bite of this insect.

Gnats or Mosquitoes.—The disturbance produced by the ordinary "midge bite" varies greatly in different persons, but there is usually much pruritus, with small wheals and considerable hyperæmia. Mosquitoes of the genus Anopheles, when infected with malarial protozoa, transmit these parasites through the skin wound (*vide* "MALARIA," vol. vi.). Similarly it has recently been demonstrated that filariasis is acquired by the sting of mosquitoes (Low,

B. M. J. 1900, i. 1456; James, *Indian Med. Gaz.* 1900, 169; Manson; Grassi and Noe, etc.). The stings of *gadflies, wasps, and bees* vary in intensity in different persons. Bee farmers are often notoriously insusceptible to the sting of bees. In most persons, however, there is great local pain and burning, followed by œdema, which is particularly troublesome when the sting is in the neighbourhood of the eye, or on the tongue or pharynx. When the bites are numerous, or when there is a marked susceptibility, there may be faintness, unconsciousness, and death from cardiac failure.

Lastly, reference must be made to the stings of the harvest bug (*Leptus autumnalis*) and of spiders, though these arthropods are not really insects.

Stinging Plants.—Certain species of plants are furnished with stinging hairs which project from the surface of their leaves, and which provide the plant with a means of defence against the attacks of herbivorous animals. The most familiar examples of plants bearing stinging hairs are the common European nettles, *Urtica urens* and *Urtica dioica*; the stings produced by the *Urtica crenulata* of India and the *Urtica stimulans* of Java are much more severe. In addition to the Urticaceæ, stinging plants are also found amongst the Malpighiaceæ, Euphorbiaceæ, Loasaceæ, etc.

In the nettle each stinging hair is essentially a single elongated cell. The basal part of the hair is expanded and flexible; the main part of the hair tapers gradually towards the upper or free brittle end, but is here again expanded to form an apical knob. Within the hair is a fluid substance, in which formic acid and probably also an enzyme are present. When the leaf is handled, the apical knob of each stinging hair which has been touched is broken off, the sharp point of the broken hair penetrates the epidermis, and the fluid contents of the hair pass into the skin.

The effects resulting from the wounding of the skin by these hairs are the characteristic lesions of urticaria, and though these usually take the form of wheals, there may be merely hyperæmia. The lesions are as a rule transient in nature, localised to the part which has been in contact with the leaf, and do not spread to distant parts of the skin. Simultaneously with the appearance of the cutaneous lesions there is locally an intense tingling, itching, or pricking sensation, as in other forms of urticaria. The toxic substance, whether it be the formic acid or a special enzyme, is thought to act directly upon the endothelial cell wall of the capillaries in the true skin, causing dilatation and congestion of these capillaries, subsequent to which there is usually excessive transudation of fluid from the vessels, resulting in the formation of the characteristic wheals.

Stipatio Telæ Cellulosæ Infantum. *See* Sclerema Neonatorum.

Stirrage.—Quickening, or the detection of fœtal movements by the mother in pregnancy. *See* Pregnancy, Diagnosis (*Symptoms, Quickening*).

Stitch-Abscess. — Abscess forming round a ligature in an operation wound.

Stitch in the Side. — Intercostal neuralgia. *See* Pleura, Diseases of (*Acute Pleurisy, Clinical History*); Pneumonia, Clinical (*Clinical Features*).

St. Ives. *See* Therapeutics, Health Resorts (*English*).

St. Leonards. *See* Therapeutics, Health Resorts (*English*).

St. Moritz. *See* Balneology (*Switzerland*); Mineral Waters (*Chalybeate*); Therapeutics, Health Resorts (*Switzerland*).

St. Nectaire. *See* Balneology (*France, Alkaline Waters*).

Stock. *See* Invalid Feeding (*Soup-making*).

Stocker's Sign. *See* Meningitis, Tuberculous (*Diagnosis from Typhoid Fever*).

Stocking, Elastic. *See* Veins, Diseases of (*Varicose Veins, Treatment*).

Stokes' Disease. — Exophthalmic goitre. *See* Thyroid Gland, Medical (*Exophthalmic Goitre*).

Stokes-Adams' Disease. — Paroxysmal bradycardia.

Stokes' Pulse.—Corrigan's pulse. *See* Heart, Myocardium and Endocardium (*Physical Signs, Pulse in Aortic Incompetence*).

Stokes' Sign. — Violent throbbing in the abdomen (to the right of the umbilicus) in cases of acute enteritis.

Stoliditas. — Stolidity, stupidity, or a markedly phlegmatic state. *See* Mental Deficiency.

Stolypin. *See* Balneology (*Russia*).

Stomach and Duodenum, Diseases of.

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See also Abdomen, Injuries of (*Symptoms, Lesions of Stomach*); Abdominal Tumours, Diagnosis of (*The Stomach*); Alcoholism (*Acute, Treatment by Washing out the Stomach*); Ascites (*Distinction from Dilated Stomach*); Atrophy, Infantile (*Morbid Anatomy, Stomach*); Children, Development of (*Stomach*); Children, Clinical Examination of (*Abdomen*); Chlorosis (*Symptoms, Dilatation of Stomach*); Cough (*Clinical Varieties, Stomach Cough*); Digestion and Metabolism (*Gastric Digestion*); Gall-Bladder and Bile Ducts, Diseases of (*Adhesions*); Gastro-Intestinal Disorders of Infancy (*Congenital Anomalies, Diseases of Stomach, Dilatation of Stomach*, etc.); Hæmatemesis; Heart, Myocardium and Endocardium (*Effects of Cardiac Disease, Passive Congestion*); Heart, Myocardium and Endocardium (*Symptomatology, Stomach Symptoms*); Indigestion (*Gastric Conditions*); Intestines, Diseases of; Lardaceous Degeneration (*Morbid Anatomy, Alimentary Canal*); Liver (*Tropical Abscess of*); Liver (*Portal Thrombosis*); Liver (*Hydatids of*); Medicine, Forensic (*Wounds, Ruptures of Internal Organs*); Medicine, Forensic (*Infanticide, Stomach Test*); Melæna; Menstruation and its Disorders (*Vicarious Menstruation*); Pharmacology (*Drugs whose Action is Mainly Local*); Physiology, Food and Digestion (*Alimentary Canal*); Post-mortem Methods (*Examination of Body Cavities, Abdomen*); Prescribing (*Administering Drugs by the Mouth*); Rheumatism, Acute (*Symptoms, Dilatation of Stomach*); Rheumatism, Rheumatoid Arthritis (*Clinical Characters, Dilatation of Stomach*); Tabes Dorsalis (*Gastric Crises*); Tetany (*Groups of Cases, Atrophy of Stomach*); Toxicology (*Post-mortem Appearances due to Poisons*); Tumours; Tumours, Inoperable; Typhoid Fever (*Symptoms, Alimentary Canal*); X-Rays (*High Frequency Currents*).

Anatomy

The stomach is the somewhat pear-shaped expansion of the alimentary canal continuous with the gullet immediately after that tube has passed through the diaphragm. It occupies the upper part of the abdominal cavity on the left side, lying in great part behind the ribs, the larger end reaching as high as the fourth left intercostal space where it is in contact with the diaphragm, which separates it from the heart, and the lower end (pylorus) where it becomes continuous with the duodenum, lying to a variable extent to the right of the middle line according to the degree of distension of the organ. The general direction of the viscus is therefore obliquely downwards and forwards from left to right, being about 10 to 12 inches in greatest length in the average adult male when moderately distended. The orifices by which it communicates with the œsophagus (cardiac) and with the duodenum (pyloric) are from 3 to 5 inches apart, and situated on the upper or smaller curvature, so that the left portion of the organ constituting the fundus extends farther to the left and higher than the cardiac opening, which lies to the left side of the body of the tenth or eleventh dorsal vertebra outside the aorta, the pyloric orifice being lower and at the level of the right side of the body of the first lumbar vertebra nearer to the anterior abdominal wall. Inasmuch as the œsophageal opening is the most fixed point of the stomach, and the pylorus is freely movable, the relative positions of these openings to each other, from before back, is subject to much variation with the state of fulness of the organ. Whilst, therefore, the cardiac orifice, into which the œsophagus opens somewhat at an angle, remains fixed in position, the pylorus, which is usually just behind the anterior edge of the liver, and lies close to the right of the median plane, 1 to 2 inches below the ensiform cartilage, when the stomach is empty, may be found 2 or 3 inches to the right when the organ is distended, and may then be in contact with the abdominal wall immediately below the liver. With the varying distension of the stomach the anterior and posterior surfaces, which are in apposition in the empty state, shift in position, the former coming to be directed more upwards instead of forwards as the organ dilates, with corresponding alteration in the posterior surface, the viscus rotating somewhat on a transverse axis.

The relations of the stomach to adjacent structures are as follows:—The upper portion of the anterior surface, along the lesser curvature and cardia, is in contact with the under surface of the left lobe of the liver; the pyloric third of the lower portion of the same surface is in apposition with the abdominal wall; whilst the remainder of the surface, as well as on the fundus and the left extremity of the posterior surface, is contiguous to the diaphragm; immediately adjacent to the phrenic area lies the internal surface of the spleen, and adjoining this to the right, the left kidney and suprarenal body come in contact with the posterior surface, and still farther to the right, reaching from the spleen to the pylorus, is the pancreas; the splenic flexure of the colon abuts on the middle of the hinder aspect of the greater

curvature; between that point and the pyloric region is the mesocolic area, the transverse mesocolon separating the stomach from the last part of the duodenum and coils of the jejunum.

The most important surface relations, in addition to those already mentioned, are—the œsophageal opening nearly corresponds with the junction of the seventh left costal cartilage with the sternum from 4 to 5 inches from the surface; the lowest normal limit of the greater curvature should not be below a line drawn $1\frac{1}{2}$ inches above the level of the umbilicus, and when the organ is empty the line is considerably higher.

The normal capacity of the adult male stomach may be as much as three pints, and is usually less. The weight of the organ is about $4\frac{1}{2}$ oz.

The duodenum is the first portion of the intestine intervening between the stomach and the jejunum. It is about 10 to 12 inches in length and 2 to $2\frac{1}{2}$ inches in diameter, being in this latter respect somewhat larger than the rest of the small intestine. It forms a curve of a shape varying with the position of the pylorus, with the concavity, in which lies the head of the pancreas, directed to the left and somewhat upwards. It is conveniently described in four parts—the first being almost horizontal from left to right and before back, moving with the pylorus, and consequently being almost directly antero-posterior when the stomach is distended and the pylorus is moved to the right. Posteriorly are the common bile duct, the portal vein, and the gastro-duodenal artery. The second portion, about 3 inches long, extends vertically and slightly backwards from the level of the left side of the body of the first lumbar vertebra close under the neck of the gall-bladder to the left side of the body of the third or fourth lumbar, from which it is separated by the vena cava, with the right kidney to its outer side; in front are the under surface of the liver, and below that the transverse colon with which it is connected by the transverse mesocolon. The third part, which forms an angular curve with the foregoing, and is 2 to 3 inches long, curves transversely and slightly upwards to the left side of the aorta, with which and the vena cava it is in contact, the inferior mesenteric vessels passing down in front between it and the transverse colon, and the head of the pancreas above. The last two inches of the duodenum, constituting the fourth part, bends upwards on the left side of the aorta to end by a sharp curve forwards in the jejunum. Behind it is the psoas muscle, and sometimes the inner edge of the left kidney; in front is the stomach, from which it is separated by the transverse mesocolon. This terminal part of the duodenum, however much the rest of this section of the canal may be displaced, maintains a uniformly fixed position owing to the presence of a musculo-fibrous band which attaches it to the left crus of the diaphragm, and this fixity is further aided by the post-peritoneal connective tissue.

The relation of these viscera to the peritoneum is of importance clinically. The stomach, except immediately behind the cardiac orifice, where it is in direct contact with the diaphragm, is completely enveloped by this membrane, which passes off the smaller curvature to the under surface of the liver, forming the gastro-hepatic omentum, and from the greater curvature to form the anterior part of the great omentum, the posterior surface of the stomach thus constituting a part of the wall of the lesser peritoneal sac. The reflection of peritoneum from the cardia to the diaphragm is known as the gastro-phrenic ligament, and that which passes from the fundus to the spleen, in which run the splenic vessels, is termed the gastro-splenic omentum. In contrast to this arrangement the duodenum is only very partially covered, the posterior surface being more or less closely connected with the post-peritoneal tissue in the neighbourhood of the kidneys and large vessels, and with the head of the pancreas. The left side of the fourth part is covered by peritoneum, which there forms several small fossæ (duodeno-jejunal). The transverse mesocolon has been mentioned as being attached to the anterior surface of the second, third, and fourth parts.

Although the stomach ordinarily appears, when viewed externally, as a single pyriform bag, marked off at the pylorus by a circular constriction from the duodenum, it will be found that functionally regarded it consists of two parts, a cardiac and a pyloric, the latter being much the smaller and of about a fourth the capacity of the other. Occasionally indications of a separation by the appearance of a slight groove on one or both curvatures, several inches from the pylorus, and sometimes a thickening (of the muscular coat) may be felt along a line joining these grooves—pre-pyloric sphincter—and a deep constriction is now and then seen, due to the contraction of the muscular fibres in this situation, showing how the organ is imperfectly divided into two unequal portions, a condition which probably obtains to a greater or less degree during the process of gastric digestion.

As seen from the inside the surface of the living stomach is found to be of a deep rose-red colour, an appearance which is quite lost after death, being replaced by an ashy-grey coloration not unfrequently marked by petechial spots. Unless much distended, the mucous membrane is thrown into numerous folds or rugæ, caused by a wrinkling of the loosely attached membrane as the muscular layers contract. These rugæ, which are mainly disposed in a longitudinal direction, are best marked along the greater curvature and less distinct towards the pylorus.

The pyloric valve or sphincter is formed by a circular fold of mucous membrane covering a special thickening of the circular muscular layer, which projects into the lumen of the canal, leaving an aperture that admits the finger, and is capable of being more or less completely closed. The inner surface of the first couple of inches or so of the duodenum is smooth, but at that distance the valvulæ conniventes commence, becoming large and of regular concentric shape beyond the papilla which marks the common entrance of the hepatic and pancreatic ducts.

Minute Structure. — The most important features in the structure of the gastro-duodenal section of the alimentary canal as bearing on disease of these organs refer to the mucosa and the disposition of the muscular tissue.

The MUCOUS MEMBRANE of the *stomach* varies in thickness with the distension of the organ, is normally thinnest over the fundus, and is covered by a layer of *columnar epithelium*, which sharply commences at the cardiac orifice, up to which in the œsophagus the epithelium is stratified. The cells have no striated border like those of the intestines, and where the surface is not secretory the cells are more granular in their deeper parts, and clearer towards their outer parts, this being due to mucigen, which is discharged during digestion. Lying among the tapering attached ends of the cells are small round or oval cells. The epithelium is set upon a basement membrane, which is composed of a layer of flattened cells; and the mucosa on the deeper side of the membrane is constructed of glands, blood-vessels, lymphatics, and nerves packed in a delicate stroma of connective and adenoid tissues, among which are plain muscular fibre cells. The glands are of the tubular variety, and are mostly but not entirely subdivided towards their closed ends, being disposed vertically to the free surface upon which they open. Two kinds of glands are to be recognised: (*a*) the pyloric glands, most numerous towards the pyloric end, open on the surface by wider mouths, the columnar epithelium being continued some distance down the tubule, forming the duct portion, the deeper portions being lined by shorter, more cubical, and finely granular nucleated cells; (*b*) the cardiac glands, more abundant at the cardiac extremity, are characterised by a shorter distance (duct) being lined by the columnar cells of the surface, beyond which the cells are like the distal cells of the pyloric glands, though more coarsely granular, and are known as the "principal" or "central" cells. Lying here and there among these, close to the basement membrane, are the parietal or "oxyntic" cells, which are much darker and more granular in the prepared specimen. The lumen of these glands is exceedingly fine, and still finer prolongations of it extend between the lining cells, distinct canalicular networks surrounding the parietal cells.

In *the duodenum* the columnar epithelium at once assumes a striated free border; the cells are somewhat shorter, but like those of the stomach secrete mucus, and present after discharge of the same the characteristic "goblet-shape" appearance. The glands met with are (*a*) the crypts of Lieberkühn, which run throughout the intestine, and are simple tubular depressions of the surface, lined throughout by columnar cells; (*b*) Brunner's glands, which are peculiar to the duodenum, in the first part of which they are most numerous; they are of the acino-tubular variety, and are more deeply placed in the submucosa, resembling in structure the pyloric glands of the stomach. Isolated masses of lymphoid tissue—solitary glands—also occur in the duodenal mucosa.

Besides the extension of the mucous surface of the duodenum effected by the valvulæ conniventes, the membrane is beset with *villi*, which are minute processes closely arranged, giving a characteristic velvety appearance, and consist of the various structural elements of the mucosa.

The submucous coat between the mucosa and the muscular layers, being separated from the former by the muscularis mucosæ, is composed of loose areolar tissue, in which the vessels and nerves ramify on their way to the mucous membrane.

The MUSCULAR COAT of the stomach consists of several layers of plain fibre cells arranged somewhat differently at different parts of the organ. Most externally the fibres are exposed longitudinally, and continuous with those of the gullet pass chiefly along the curvatures of the stomach, being much less distinct over the surfaces, to the pylorus, where they blend with the corresponding fibres of the duodenum. The middle layer of fibres are circular in direction, forming a complete investment of the organ from fundus to pylorus, where a specially thickened bundle forms the pyloric sphincter. The most internal fibres are distributed obliquely over the surfaces of the stomach, and whilst well marked over the fundus scarcely reach the pyloric end.

In the duodenum, as in the rest of the small intestines, the muscular tissue forms an outer longitudinal and an inner circular layer, the latter being much the thicker. No extension of this coat into the valvulæ conniventes takes place.

The SEROUS COVERING, which is complete, or almost so, on the stomach, and only partial over the duodenum, allowing by its elasticity the varying distension of the organs, is an exceedingly thin homogeneous basement membrane upon which is a layer of flattened endothelium, and connected by areolar tissue with the subjacent coat. Where the peritoneum is wanting the areolar tissue becomes continuous with the post-peritoneal connective tissue.

VASCULAR SUPPLY. — The arteries of the

stomach are derived from the three branches of the cœliac axis, viz.: the coronary artery, which is distributed over both surfaces, chiefly towards the cardiac end; the right gastro-epiploic and the pyloric branches of the hepatic artery supply the pyloric end of the stomach and the right part of the greater curvature, as well as the duodenum; and the left gastro-epiploic, which arises from the splenic branch of the cœliac axis—from this vessel the fundus obtains its supply. These several vessels freely communicate with one another, and also with the œsophageal branches of the aorta around the cardia. By these channels a large amount of blood is distributed to the viscera by branches which pierce the muscular coat, and after further dividing in the submucosa, form a close network in the mucous membrane between the glands, and in the duodenum extend into the villi. The blood is returned by veins which correspond to the arteries, and finally contribute to form the portal vein. There is also an extensive communication at the cardia with the œsophageal veins, which reach the superior vena cava *via* the right azygos vein.

The LYMPHATIC VESSELS commence in lymph spaces in the mucosa among the glands and blood-vessels. Thence they pass through the muscularis mucosæ, and form plexuses in the submucosa, whence large branches pass through to the surface of the organs, and finally reach the thoracic duct, passing in their course through various retroperitoneal lymphatic glands.

The NERVES of the stomach originate from both pneumogastrics, the terminal branches of the left being distributed over the anterior surface, and those of the right over the posterior surface, chiefly towards the pyloric end.

Branches of the sympathetic system from the solar plexus also reach the stomach. From all these nerves branches pass through the walls of the stomach and duodenum to communicate with gangliated plexuses lying between the muscular layers (Auerbach) and in the submucosa (Meissner). Filaments from these supply the muscular tissue of the mucosa.

Thus the efferent and afferent channels to and from the viscera (stomach and duodenum) and the nerve centres lie in the vagi, and in the white rami communicantes of the sympathetic from the tenth to the sixth dorsal spinal segments. And since, as Dr. Head has shown, the referred pains and areas of tenderness in diseases of these organs are arranged on the body surface in accordance with the distribution of the skin fields of the spinal ganglia, rather than with that of the peripheral nerve-trunks, some of these areas of reference are cranial and cervical as well as situated on the body.

Digestion in the Stomach and Duodenum

Digestion is that physico-chemical process whereby the food is converted into a fluid and diffusible condition suitable for absorption directly or indirectly (*via* the lacteals) into the blood-current. It is in some measure anticipated by, and is a continuance of, the changes which are affected by cooking. Some of the food taken is absorbable at once, whilst other constituents are incapable of solution in the alimentary canal, and are consequently indigestible. The digestibility of food therefore depends on the facility and completeness with which it is reduced to a diffusible state; its nutritive value, which is a different matter, being in proportion to its suitability for tissue-construction and metabolism.

For the carrying out of the function there are required various solvent juices to deal with the several kinds of alimentary principles, some arrangement by which these fluids and the food are mixed and propelled, and an adequate removal of the digested food-stuffs (digesta), an accumulation of which interferes with the proper progress of the digestive changes. These requirements are met (i.) by the alimentary canal, which is a tube of great length, presenting various alterations in size and situation in its course, which allow such opportunities for delay in the progress of the contents as are necessary for the efficient action of the solvents; (ii.) by the secretions of the salivary, gastric, pancreatic, and intestinal glands, which are abundantly poured into the canal; (iii.) an extended absorbent surface, which is furnished by the mucous membrane with its vast area of valvulæ conniventes, villi, etc., where the blood capillaries and lacteal radicle are brought into close relation with the digested material; (iv.) a sufficient blood and lymph supply; and (v.) a controlling and co-ordinating nervous mechanism, which is derived from the cerebro-spinal and sympathetic systems, as well as an intrinsic arrangement of ganglia and fibres.

With one section alone, viz. the stomach and duodenum, is this article concerned, but preceded as gastric digestion is by those changes which should be effected in the mouth, its relation to them has to be borne in mind. It has also to be remembered that the stomach is not an indispensable organ. Several cases of its total extirpation have now been recorded, the patients completely recovering, and some at least being able to return to an ordinary diet, with the maintenance of complete nitrogenous equilibrium and gain of weight. On the whole, gastric digestion is in the main preparatory to the more extensive and elaborate changes which take place in the intestines, where also the greater amount of absorption of the digesta occurs. The subject of normal digestion has been so fully treated (see articles "Diet," "Digestion and Metabolism," vol. ii. pp. 350, 365) that it is sufficient here briefly to indicate the main features of the process, so far as the stomach and duodenum are concerned, as a

basis for the consideration of disturbances of the function (indigestion or dyspepsia) and of diseases of the organs involved.

Clearly the first consideration in respect to digestion is the food, its nature and character, more particularly the quantity and its apportionment into properly regulated meals at suitable intervals; the state of mechanical subdivision as effected by cooking, mastication, etc., in which it is presented to the gastric mucosa; its freedom or otherwise from physically injurious or poisonous constituents; and lastly, its nutritive composition, containing, that is, the needful proportion of the several alimentary principles.

From the aspect of gastric secretion there is required for a normal digestion a sufficient quantity of the fluid, with no deficiency and no great excess of hydrochloric acid (·1 to ·25 per cent), poured into the stomach when food is there and not in the intervals when the organ is empty, which partly combines with the proteids present and in part (not more than 1 per 1000) remains free. By this agent, combined with pepsin, the proteids are chiefly digested and passed on into the intestines as albumoses and peptones. The chief proteid of milk, caseinogen, is coagulated and converted into casein by a special enzyme (rennin), and is afterwards peptonised by the pepsin and hydrochloric acid.

The digestion of the starch elements of the food which has been commenced by the ptyalin of the saliva is arrested by the free hydrochloric acid, and hence an excess of meat food in a meal gives a better chance to the continued digestion of the farinaceous food in the stomach by using up the acid, whilst an excess of starches or sugars diminishes the opportunity of their conversion. Further, the normal lactic, acetic, and other bacterial fermentations which take place in the stomach in the carbohydrate foodstuffs partially increase after the middle period of gastric digestion, but are normally held in check by the free hydrochloric acid present, whilst a deficiency of this material or a great excess of carbohydrates leads to the formation of undue quantities of the organic acids.

The neutral fats of the food ordinarily undergo but little change beyond being melted in the stomach, only a slight decomposition and liberation of fatty acids, possibly due to bacterial agency. Hence portions of meat or other substances, that might be satisfactorily dealt with in the mouth or stomach, may pass on undigested if coated with a layer of fat such as melted butter.

The various salts, phosphates, carbonates, malates, and other inorganic compounds occurring in the food undergo some decomposition due to gastric juice, the hydrochloric acid of which is derived from the sodium chlorides. Excessive quantities of some of these substances are apt prejudicially to affect the activity of the gastric secretion.

The mutual interference of the several alimentary constituents in the course of their digestion in the stomach is a circumstance of considerable importance, and to be taken into account in the treatment of dyspepsia and the framing of a suitable dietary. And still more is this so in respect to certain food accessories, such as alcohol, tea, coffee, and condiments. The first-named, unless very concentrated, appears to be less harmful to digestion than is ordinarily supposed, and being one of the few materials which are absorbed from the stomach, its stimulant effect on the circulation may be actually beneficial, especially in a condition of exhaustion. Experimentally, it has been shown that tea and coffee do interfere with the peptic digestion of proteids.

The normal stimulus to the gastric secretion is less the contact of the food with the mucosa than the chemical qualities of the ingesta and the psychical states of appetite, sight and smell of food, with the pleasurable anticipation of a meal in agreeable surroundings. Hence some secretion takes place even before the food is swallowed. Moreover, it is said that different kinds of food excite the secretion of a juice best fitted for its own digestion, richer or purer in ferment or acid, and in greater or less quantity as may be required. Some alimentary principles, as fats, appear even to prevent the secretion. Important, if true, as enabling digestive habits to be readily established.

The germicidal action of the gastric juice is also a fact that has important bearings, by restricting the fermentations which normally take place in the stomach, and also by destroying many pathogenetic organisms which enter with the food.

Regarded as a whole, the digestive changes which take place in the stomach may be looked upon as a preliminary—desirable, but not essential—to those which are carried on lower down in the intestine. During the very short time occupied by the passage of the chyme through the first half of the duodenum nothing special is to be noted; but below the entrance of the biliary and pancreatic ducts the alkaline fluids then poured into the canal neutralise the acidity of the chyme and cause a precipitation of albumoses. The way is also cleared for a further digestion of the proteids, and of the starches and of the fats, by the pancreatic juice.

The efficiency of the gastric juice will be likely to be impaired if too much fluid be taken with meals, thereby unfavourably diluting the secretion. At the same time harm may result from a too sparing fluid diet by hindering the adequate mixing of the stomach contents. This mixing is effected by the normal churning movements of the cardiac two-thirds of the organ, and since it is in this region that the

hydrochloric acid is almost entirely formed by the parietal cells, it is there that the digestion takes place. When the material is reduced to a sufficiently fluid condition, it is passed on through the pre-pyloric sphincter into the pyloric region by more or less rhythmically propulsive efforts, by which it is propelled through the relaxed pyloric orifice. It would also seem that the antrum pylori can reject and force back towards the fundus such solid masses as may have escaped solution. These movements of the stomach are mainly stimulated by the character of the food, warm and hot ingesta specially exciting them; and though over-acidity calls forth the peristalsis, it appears to induce a spasmodic and even painful spasm of the pylorus with consequent hindrance to the escape of the chyme. Normally, the passage through the pylorus of the fluid foods, unless requiring gastric digestion, begins to take place as soon as swallowed. The movements of the duodenum are of the ordinary vermicular form of peristalsis such as the rest of the intestine presents.

For the efficient performance of these motor and secretory processes it is obvious that a satisfactory state of general nutrition, an unimpeded and adequate blood-supply, and even more especially a healthy and undisturbed nervous control are essential. Exertion, whether mental or bodily, directly after a meal is apt to be harmful, probably by interfering with the requisite blood-supply. The same may be said for sleep under like circumstances. It is also desirable that the digesta should be got rid of without delay, and this is done, as described, by the propulsion of them into the duodenum, for as a rule very little absorption takes place by the gastric mucous membrane, although some salts, sugars, peptones, and alcohol do enter the blood from the stomach, especially the last named. In this restricted absorptive capacity of the organ may be seen a protection to the body generally, supplementary to the further protective power exercised by the germicidal action of its secretion. The absorptive power of the stomach is, however, of some value, as indicated by the experiments of Heidenhain, which go to show that the efficiency of the gastric secretion is partly dependent on materials absorbed at the commencement of digestion. In the duodenum, or at all events in its lower part where the villi and valvulæ conniventes are well developed, a greater range of absorption most probably takes place.

There is a function of the stomach of which but little is positively known, and still less what share it may take, if any, in normal digestion, and that is its excretory power. Various substances, for the most part toxic, such as antimony, morphia, toxalbumins, and toxalbumoses, have been known to pass from the blood-vessels of the stomach into the organ, and then to produce their poisonous effects by local irritation or by re-absorption.

Lastly may be mentioned the fact that in the healthy state the activities of the stomach and duodenum are carried on without conscious sensation to the individual. The healthy appetite appears in great measure to be connected with the condition of the stomach, and is allayed by the taking of sufficient food. But it is not a mere question of the stomach being empty or full, since there may be anorexia when the viscus is quite empty but the mucosa is unhealthy, or the desire for food may quickly follow a full meal. Even more than with many other of the bodily functions, the influence of habit is potent in modifying the processes of digestion within limits that are not detrimental to the individual's well-being.

Diseases of the Stomach and of the Duodenum

In entering upon a consideration of the diseases of these organs it is necessary to remember that there are two groups of morbid conditions met with, which are more or less independent, at least in origin, though constantly associated and to be investigated from different standpoints and by different methods. On the one hand are structural diseases of the organs, such as ulcer, inflammation, new growths, etc., whether primary in occurrence or determined by malnutrition of the body generally or by special disease of other parts, and characterised by certain signs and symptoms, local and remote, from which the nature of the lesion may be inferred. In connection with such diseases the digestive process, as carried out in the stomach or duodendum, will be likely to suffer more or less as the motor and secretory functions of the organs are interfered with by the morbid changes therein. On the other hand are perversions of digestion arising for the most part independently of previous structural change in the organs, and attributable in the first place to the qualities of the ingesta or the mode in which they are presented to the stomach from the mouth, to imperfections in the composition or quality of the gastric or duodenal secretions, to inefficient or excessive motility of the stomach, to nervous disturbances, or to other interferences with digestion that may be, primarily at least, due to causes apart from the organs immediately concerned. At the same time it must be admitted that the maintenance or constant repetition of such conditions may be the determining factors in the production of structural disease of the stomach or bowels. In approaching the subject of stomach disease, therefore, the difference between gastro-duodenal indigestion or dyspepsia, and definite structural lesions of the organs, must to some extent be kept in mind in the proper analysis of the symptoms presented and in the pursuance of treatment.

A further general observation appears desirable. Whilst it is the diseases of the stomach and duodenum and perversions of their functions that will be here described, the clinical necessity for their consideration in relation to other organs and other functions cannot be too strongly insisted upon, and especially for the formation of a prognosis and of a rational therapeutic plan. A too restricted view of gastro-duodenal disease, as indeed of any other organ, will be likely to furnish a very imperfect conception of the case as a whole, though this is difficult to avoid in the conditions imposed by a descriptive article of limited extent.

General Etiology

Affections of the stomach are amongst the commonest of maladies. So closely associated are its functions with others, that few diseases, whether acute or chronic, are not sooner or later complicated by gastric disturbance. Certain circumstances, however, would seem to confer a special liability, and so far may be regarded as predisposing causes, as others are more surely responsible for the actual determination of gastro-duodenal disease (exciting causes).

Heredity.—How far any disease of the organs under consideration can be said to be the result of hereditary influence is exceedingly doubtful. Not infrequently, however, definite structural disease may develop in several members of a family in the same or succeeding generations as to suggest an explanation of this kind. Dr. Dreschfeld (Albutt's *System of Medicine*, vol. iii. p. 520) has recorded eight examples of gastric ulcer thus occurring. Still more numerous are the cases of cancer of the stomach, with a family history of malignant disease—14 per cent in 1744 cases as determined by Welch—and commonest of all is the existence of a "weak digestion" in parent and child. Dyspepsia of neurotic causation seems specially liable to be transmitted. Notwithstanding the figures that can be adduced in support of this view, it is doubtful whether, when not merely coincidence, they are anything more than an expression of the hereditary transmission of a tendency due to a deteriorated resisting power on the part of the tissues concerned, and requiring for the development of the malady a special excitant, such as members of the same family are likely to be exposed to, whether this be habit of life, diet, or the like.

Age, as influencing the incidence of gastro-duodenal disease, is undoubtedly potent. Acute catarrhal affections are of great frequency at all ages, and children and infants are especially prone to suffer, the conditions being determined by comparatively slight causes, but it is to be noted that in such cases the intestine shares in the catarrh more frequently than in later life. The graver condition of phlegmonous gastritis is seldom met with except in adults, and the same also with cirrhosis ventriculi. Ulcer of the stomach is much more common between the ages of fifteen and thirty than at other periods, whilst a similar lesion of the duodenum tends to occur later, viz. from thirty-five to forty, if cases following on burns be excluded. Very rarely such ulcers have been seen in both situations in infants, and especially those born in difficult labours, suggesting the probability in these cases of local hæmorrhages into the mucosa and subsequent necrosis resulting therefrom.

The greater number of cases of carcinoma ventriculi are met with between the ages of fifty and sixty, and very few are seen before thirty, although Dr. N. Moore records a case in a girl aged thirteen, and Drs. Osler and M'Crae have collected the accounts of thirteen cases between the ages of ten and twenty. A well-authenticated case of a cylindrical-celled carcinoma in an infant under a month old, probably congenital, was described by Cullingworth (*Brit. Med. Jour.* 1877, ii. p. 253). Sarcoma of the stomach, which is much rarer, has been known in several cases to have occurred under twenty.

Some curious but unexplained differences exist in the *sex* incidence of gastric and duodenal disease, the most remarkable being in connection with the so-called peptic ulcer, which occurs with more than three times the frequency in young females than it does in males when situated in the stomach, but thrice as often in middle-aged males as in women when located in the duodenum, except as the sequence of burns, when the greater number is in females. In the much rarer affection, phlegmonous gastritis, the preponderance in males is very marked. The frequency of malignant disease in the stomach is somewhat greater in males, and much more so when the duodenum is the seat of the growth. It is difficult to explain these facts in any essential proclivity in either sex, and in other maladies of the stomach—catarrh, dilatation, chronic congestion, cirrhosis, etc.—no such differences are to be found.

The predisposing effect of the nervous *temperament* is seen rather in the very important part it takes in determining indigestion, than in the actual causation of structural disease of the organs concerned, though even here its influence cannot be regarded as altogether wanting. The most obstinate disturbances of gastric motility or secretion are in many cases solely to be attributed to a neurotic temperament, and persist in spite of the most careful regulation of the other factors concerned in digestion.

Here may be mentioned the peculiar idiosyncrasies exhibited by certain individuals in respect to certain articles of food, which to the majority are harmless or even beneficial, but to them are positively poisonous. Among such are fish, shell-fish, vinegar, etc. The undue susceptibility of some persons to gastric disturbance

from emotional or reflex causes may be referred to.

Race, *occupation*, *season*, and *climate* exert such influence as they do in the causation of structural disease or functional disturbance of the stomach and duodenum, less by any direct effect, than indirectly by affecting the general health, the character of the food, and other such circumstances.

Among the immediate or *exciting causes* of diseases of the stomach and duodenum, by far the most important are errors connected with the ingesta, and of these especially the *food*. Now the food may be regarded as acting as a determinant of gastric disease in two ways, separately or combined: either by its direct action on the mucous membrane in virtue of its physical, thermal, chemical, or toxic characters; or when, from its quality or quantity, or from imperfections in the digestive capacity (secretory or motor or both) on the part of the individual, the food is improperly digested, and thereby becomes an irritant to the mucosa, setting up a varying degree of catarrh. Within the former category may be enumerated a diet containing an undue proportion of mechanically irritating particles such as seeds, fibres, etc.; food that is too hot or too cold, or that is too acid, as vinegar, pickles, or with an excess of pungent condiments as pepper; the habitual taking of a large quantity of salt has been known to be provocative of gastric disturbance, whilst a salt-free dietary is also harmful. Or the food may be actually poisonous from changes that have taken place in it, producing ptomaines and toxic albumoses. The mal-digestion of food and consequent gastric affection may be due primarily to the food itself, or to some digestive imperfection originating apart from the stomach itself, such as a nervous disturbance of its secretory or motor functions. A bulk of food beyond that which the organ can satisfactorily deal with, masses of food inadequately masticated or divided, portions of meat or other nitrogenous substances enveloped in a coating of greasy sauce, an undue amount of sugar, fats, or alcohol, leading to lactic, butyric, and other fermentative changes which give rise to irritating substances, will all tend so to affect the lining membrane of the stomach as to establish a gastritis, temporary though it be, and are much aided by any circumstances which delay the passage onwards of the stomach contents. Obviously, general states of ill-health, such as anæmia, chronic renal disease, nervous exhaustion, mental, emotional, and bodily fatigue, will, by interfering with the proper secretion and motility of the stomach, bring about indigestion, and thus favour the development of a gastric catarrh if not of other morbid states. Too much fluid at or directly after meals may interfere with digestion by its diluent effect on the gastric juice. Too little fluid may be also detrimental. The taking of food, however good in itself, at too frequent intervals, interfering with the digestion and removal of what is in the stomach, is another cause of dyspepsia, although habit in this as in other cases often diminishes its ill effects.

Most varied are the *toxic substances* that may gain entrance with the food, although they are in no sense a part of it, but merely accidental accompaniments. Among the most important are micro-organisms, many harmless, some pathogenetic. The antiseptic power of the hydrochloric acid of the gastric juice renders by far the larger proportion of them inert; but in the absence of this agent from the stomach, whether from a deficient secretion or in the intervals when the stomach is empty, such organisms find an opportunity for their development and the production of their injurious effects. In this way persistent suppurative conditions in the mouth and pharynx, carious teeth, and the food and other accumulations which collect under ill-fitting dental plates, etc., may, by the constantly swallowed pyogenic microbes, become a serious and often unsuspected cause of gastric disturbance, by the setting up of a septic catarrh.

Another group of toxic substances are the metallic poisons with which the food may be contaminated, such as lead, arsenic, and copper. The cumulative effect of minute quantities of such substances constantly taken leads sooner or later to gastric or gastro-intestinal inflammation. Alcohol, especially apart from food and in the form of spirits, is a potent factor in diseases of the stomach, both acute and chronic, and appears responsible for favouring the incidence of some morbid states by the effect that it has in impairing the digestion as well as by its destructive action on the walls of the viscus.

The injurious results of *wounds*, blows, or severe compression, of articles swallowed, such as pins, bones, etc., or of corrosive fluids, are as obvious as they are seldom met with, the last named alone having any special bearing on the production of stomach disease.

An occasional cause of gastric derangement is a general *adhesion* of the organ, as the result of previous peritonitis, to neighbouring parts. The peristaltic movements may thus be considerably interfered with, and a very painful dyspepsia ensue, leading in turn to a chronic affection of the mucous membrane. Similar effects follow displacements of the organ, and especially abnormal distension of it. These conditions may all be supposed to act chiefly by delaying the adequate removal into the intestine of the stomach contents, and thus favouring fermentations and formation of irritant substances, the continued effect of which is the establishment of a gastritis.

The gastric secretion, and particularly when

its *acidity* is increased, as frequently occurs, is itself responsible for certain morbid states by exerting a digestive action on limited areas of the stomach walls, the vitality of which has been impaired by mechanical damage, by degeneration, by obstructed circulation, or by other conditions of disease. It is this which is undoubtedly the most potent factor in the production of gastric ulcer.

Less often, but still with a frequency greater than is probably supposed, the causation of a stomach affection is to be found in irritating or toxic bodies, such as albumoses, *excreted* by the mucous membrane. Such substances may conceivably have been formed and absorbed lower down in the alimentary canal, and subsequently excreted by the stomach, or they may have originated in perverted tissue metabolism. In this way the gastric symptoms in irregular gout may be explained, though a precipitation of crystalline sodium biurate in the stomach coats has also been held to account for them. The association of duodenal, and less often gastric, ulcer with extensive cutaneous burns has been supposed to be due to poisonous bodies formed at the seat of injury and eliminated by the bile, causing a duodenitis with ulceration.

The influence of *cold* and *damp* in the causation of gastric and gastro-intestinal catarrh is undoubted, and especially in infants and children, whose alimentary mucous membrane is quite as likely, if not more so, to be affected as their respiratory surface. Individual proclivity in this direction is often to be noticed among adults, with whom changes in the weather are apt to be marked by gastric indigestion, diarrhœa, etc.; and the intensifying effect of cold and wet upon an existing chronic catarrh is well known. The exact pathogeny of these climatic states is still uncertain, but a disturbance of the circulation, with engorgement of the portal area, seems to be an important factor; whether special poisons are formed by the altered vascularity of skin and viscera is unknown, or whether the congestion simply renders the mucous membranes more susceptible to ever present injurious influences.

Extreme heat appears to act by the general exhaustion it tends to produce, rather than by any direct effect on the stomach.

Secondary to other Diseases.—There is scarcely any bodily ailment, however slight or however severe, that does not tend sooner or later to interfere with the digestive function, be it only a transient impairment of appetite or a lasting state of catarrhal disturbance. Space forbids more than a reference to the chief groups of disease.

Indigestion and severe gastric catarrh are the usual accompaniments of an infective disease, at least during its acute stage, and this has been attributed to an eliminative effort on the part of the gastro-intestinal mucosa to get rid of toxic substances formed. An extreme example of this is typhoid fever, though the stomach seldom exhibits ulceration, and the duodenum very rarely.

A family history of tuberculosis has been met with in a considerable proportion of cases of gastric cancer, and in many post-mortem examinations of this disease retrograde tubercle has been found by Drs. Kingston Fowler and Martin.

As might be expected, an imperfect digestion frequently complicates general states of malnutrition, such as chlorosis and other severe blood affections, rickets, obesity, malignant disease outside the alimentary tract, syphilis, etc. The perverted metabolism which in various ways characterises these maladies affects the structures of the gastro-intestinal canal, and with that it may be supposed the completeness of their functional activity, and hence indigestion.

Very marked are the gastro-intestinal derangements that are associated with obstructed portal circulation, whether this be due to hepatic disease or to morbus cordis, and very obvious digestive improvement will often follow a relief of the congested vessels.

Affections of the stomach secondary to diseases of the respiratory tract are not infrequent. Vomiting is a common sequence of severe coughing. Gastric catarrh may be set up by the exposure which has brought about a bronchitis, and the stomach may with the lungs exhibit the effects of pneumococcic infection. Tuberculous disease of the alimentary tract has been attributed to the swallowing of sputum from phthisical lungs.

Reference has already been made to the dependence of gastritis, and it may be added of other affections, upon mal-excretion from renal disease.

The relationship of nervous maladies to functional derangements of the stomach is rather to be seen in those cases where pain is a marked feature, or in other affections of the higher brain powers, nervous exhaustion, emotional outbursts, hysteria, neurasthenia, or mental perversions. The influence of these conditions upon appetite and digestion are well established, and the nervous temperament, even within a range consistent with health, has been mentioned as the cause of a large proportion of dyspeptic conditions, presumably by impairing the nerve control of the gastro-intestinal secretion and motility. The violent attacks known as gastric crises which occur in the course of tabes dorsalis claim a more obvious structural change in the nerve centres for their causation. The vomiting in certain cerebral diseases comes within the same category.

Lastly may be mentioned, among the causes of diseases of the stomach and duodenum, affections of those organs themselves which stand in a primary relationship to other morbid states.

Thus some degree of gastritis is a constant associate of malignant disease of the organ; dilatation of the viscus is in a large proportion of cases due to obstructive conditions at the pylorus or in the duodenum; a connection has been traced between carcinoma ventriculi and the scar of a former ulcer, and also, perhaps, with a long-standing indigestion, although the association in these cases is not perhaps so frequent as has been supposed.

Morbid Anatomy and Pathology

The usual post-mortem appearances even of the healthy stomach and intestine differ considerably from those seen in the same organs during life. The normal shades of pink which the mucous membrane exhibits according to the condition of digestion and the delicate velvety look are no longer seen; the surface is pale and greyish in colour, occasionally streaked by the lines of blood-vessels, or even spotted with minute hæmorrhages, and of a somewhat glairy and viscid appearance. This last is due to a softening of the epithelial cells, which become indistinct in outline, loosened and separated from the basement membrane, and mixed with the mucus resulting from the degeneration of the cells. Should death have taken place whilst food is in the stomach and digestion is in progress, the extent of the softening—gastromalacia—is much greater, and may amount to actual destruction of large areas of the mucosa and even of the muscular and serous layer, producing extensive and ragged rents in the organ, with escape of the contents, and similar invasion of the diaphragm and contiguous structures. This post-mortem digestion, which is most apt to occur in children, is most marked at the fundus, and may only be represented by quite small erosions of the surface. There is usually some, and perhaps considerable, staining of the tissues of the stomach by the blood, which has undergone change by the gastric juice. After a time putrefactive decomposition supervenes. The first part of the duodenum may be involved in the destruction along with the stomach, but on the whole this is rare.

Congestion and Hæmorrhage.—As already said, the post-mortem appearance of the gastro-intestinal canal is but little indication of the actual state of its vascularity during life. Under conditions such as portal obstruction or obstructive heart disease, where the due return of blood is interfered with, the resulting congestion of the mucosa may persist to a greater or less extent after death, and an extreme fulness of vessels and coloration of surface may be seen, especially along the curvatures and towards the pylorus. Distinct varicosity of the veins around the cardiac orifice may occur at the junction of the coronary and œsophageal vessels—gastric hæmorrhoids; the non-persistence, however, of such vascular dilatations after death is not to be taken as evidence of their absence during life.

It will be readily understood that, where the mechanical congestion has been intense, rupture of the small vessels is liable to take place, especially when these are so imperfectly supported in the lax tissues of the mucosa and submucosa; hence interstitial hæmorrhages are common in such cases, and according to their size and extent they may reach to the surface, with consequent effusion of blood into the viscus. Grave alterations in the blood, such as leucocythemia, scurvy, etc., jaundice, or minute emboli from malignant endocarditis, may all give rise to hæmorrhages into the mucous membrane and deeper layers. Along with recent petechiæ, or even without them, may be seen spots of pigmentation, the results of former hæmorrhages.

Inflammation—Gastritis.—The response of the constituent tissues of the stomach to the infliction of an irritant that exceeds in degree or kind those to which it is normally subject and is yet not of that severity to cause complete destruction—in short, the process of inflammation—varies much with the character of the irritant, and also with the condition of the individual.

In its simplest form—*catarrh*—it is one of the most frequently occurring of all maladies, induced as it is by the numerous errors of diet or improper ingesta to which the stomach is exposed; or when the viscus is reacted upon by disturbances in the digestive process, that depend upon causes apart from structural defects in the organ itself, determining by their irritant character mild inflammatory results, which in their turn intensify the indigestion.

The mucous membrane in *acute gastric catarrh* has been seen to become of a deeper red from hyperæmia, more marked in places and not completely uniform. At first the surface is probably drier than normal, but is soon covered with a layer of thick tenacious mucus due to an increased reaction by the epithelial cells, which rapidly undergo a more extensive mucoid degeneration than obtains in the normal state. Similar changes, and more especially those of a granular character, are found in the cells of the gastric glands—with the result, as may be mentioned in passing, of causing a diminution or complete arrest of the pepsin and hydrochloric acid secretion. Moreover, the cells become loosened in their attachments and desquamate, their place, on recovery, being subsequently taken by the round cells which lie among their deeper ends. Meanwhile the lower layers of the mucosa and of the submucosa are œdematous, infiltrated to a varying extent with leucocytes, some of which escape at the surface with the epithelium and mucus. The readiness with which slight hæmorrhages occur in even the milder forms of gastritis is a noticeable

feature, whether they be into the tissues or an actual escape at the surface. Ordinarily these changes, which are rapidly established, are transient and quickly recovered from, with a complete return of the tissues to their normal state. But should the irritation be frequently repeated or persistent in character, a more chronic change is set up, which is recovered from with difficulty or not at all.

The characteristic changes in the stomach which are associated with a *chronic catarrh* are, in the most marked cases, an atrophy of the epithelial and glandular elements of the mucosa, with or without a fibrotic overgrowth, and usually with some, or may be much, pigmentation, causing the mucous membrane to be of a grey and slaty colour with darker spots of variable extent. According to the degree of the fibrosis will be the thickness of the membrane. In extreme cases this may be considerable, the surface being raised into irregular projections, sometimes almost polypoid, from the overgrowth in the deeper part of the mucosa and submucosa. When this condition has not developed, the remains of the mucous membrane largely, though irregularly, denuded of epithelium and with shrunken and wasted gland tubules, which have here and there undergone cystic dilatation, is thinner and smoother than normal and with but little of the mucus secretion that, in varying amounts, is seen in the healthy state. This condition may develop as the sequence of repeated attacks of acute gastric catarrh, or may arise with no obvious acute commencement; it is also a constant associate of other morbid states of the stomach, such as dilatation, cancer, etc.

When the irritant to which the stomach has been subjected is of an intensely severe nature, such as the concentrated mineral acids, strong alkalies, or metallic irritants (arsenic, corrosive sublimate, etc.) there will follow their ingestion a sloughing of the stomach walls, depending for its extent both in depth and area on the strength and quantity of the poison. The tissues are at once destroyed, the resulting slough presenting certain recognisable differences according to the destructive agent. Thus whilst the eschar caused by the strong acids is somewhat hard and brittle—mainly from dehydration of the tissues —those from alkalies are softer, moist, even somewhat gelatinous. As regards colour they are generally of a greyish-white appearance, being a dead white from corrosive sublimate and carbolic acid, and yellow or orange from nitric acid. The tissues immediately adjacent to the necrosed portions are in a state of violent inflammation, extensively infiltrated with blood, which is quickly altered and causes a brown to blackish discoloration, with all the other appearances of acute gastritis to a severe degree. If any of the irritant have passed through the pyloric orifice similar appearances will be seen in the duodenum. Should recovery follow, the destroyed areas are replaced by scar tissue which tends to contract, so producing great thickening and perhaps distortion of the organ.

Infective Gastritis.—Owing to the inimical effect of the hydrochloric acid of the gastric juice upon most of the micro-organisms that gain entrance to the stomach, gastritis of an infective character is of comparatively rare occurrence. When, however, the acid is deficient in quantity, or the microbe is unduly abundant or very virulent, it may be presumed that inflammation will result from their invasion of the mucosa.

(*a*) Pyogenic or Phlegmonous Gastritis.—The specific form of gastric inflammation so designated is of infrequent occurrence, and appears both as a diffuse and a localised suppuration. In the former the submucosa is the main seat of the process, this layer being hyperæmic and infiltrated with leucocytes and a fibrino-serous effusion, which commonly permeates among the glands of the mucosa and also invades the muscular layer, and may even extend into the subserous tissue and involve the peritoneal covering, thereby causing a peritonitis either limited or general. In this way the thickness of the stomach walls is much increased and may be dotted here and there with hæmorrhages into the tissues, the glandular epithelium being in a state of cloudy swelling. Such a condition has been compared to an erysipelatous inflammation of the skin. Although several organisms are doubtless responsible for this condition, the only one as yet recognised with certainty is the streptococcus. How the infection invades the stomach wall is often uncertain; as a part of a general pyæmia, the state is intelligible, and wounds, operation and other, of the organ, as well as ulcers or other breaches of continuity of surface, may be supposed to admit the entrance of such pyogenic microbes as have escaped the action of the hydrochloric acid, but such lesions are often entirely absent. In the course of the disease the pus may burst through the mucous membrane and discharge into the stomach at many points, giving the thickened, boggy walls a honey-combed and broken-down appearance, or similarly the pus may break through the muscular and serous coats into the peritoneum. Occasionally this condition has been known to extend into the duodenum. In the localised or circumscribed variety the collections of pus may form one or more abscesses, ranging "in size from a bean to thrice that of a man's closed fist" (Dr. Leith in Allbutt's *System*, vol. iii.), which may rupture into the stomach, or outwards into the peritoneal or even the pleural cavity or through the abdominal wall.

(*b*) Membranous Gastritis.—In this variety, which is usually associated with scarlet fever, diphtheria, variola, or pyæmia, and more especially in children and in those whose

nutrition has been profoundly deteriorated, the inflammatory products form more or less coherent membranes or follicles in patches on the mucous surface. Most commonly similar patches are to be seen in the mouth or fauces, and this is to be expected oftenest in diphtheria. The membrane, of a yellowish-grey or brownish colour, may be quite superficial and consisting of leucocytes and coagulated fibrin involve only the epithelium of the mucosa, or the deeper tissues may be implicated in the patch. Various micro-organisms are to be found in the membrane, the Klebs-Löffler bacillus characterising the diphtheritic state. A well-marked form of membranous gastritis has been described as the result of pneumococcic infection (Foulerton). Resembling these pellicles somewhat in appearance, and indeed in nature, are those superficial sloughs which are among the effects of the strong corrosive poisons and metallic irritants already described. In later stages of this lesion, after the membrane has been thrown off, the mucosa is left ulcerated with destruction of the tissues to varying depth.

(*c*) Some gastritis is not infrequent in association with pulmonary tuberculosis, in part determined, it is supposed, by the swallowed sputum but often present before any pulmonary disease is to be recognised, and then probably due to the septic products developed in the course of the associated hectic fever, and rare cases of tuberculous ulcer have been seen. The infrequency of lesions of this nature in the stomach as compared with intestinal tuberculosis is remarkable; in the duodenum, however, they are somewhat more common, but much less so than in the lower part of the canal.

A duodenitis may exist as an extension from the stomach or as a part of a general gastro-enteritis; how far a condition of inflammation limited to this region occurs is conjectural. The possibility, inferred from some experimental observations, of such a state arising from the excretion of irritant substances in the bile, derived from superficial burns, has been alluded to.

The observations of Drs. Perry and Shaw upon morbid conditions of the duodenum led them to notice a close association between enlargement of Brunner's glands and "diseases due to specific organisms."

Atrophy.—A wasting of the tissues of the stomach and intestines occurs as a part of the atrophy of the senile state, or in other cachectic states associated with marasmus. As already described, it is a result of a chronic catarrh of these organs, though there may be a coincident fibrosis causing a thickening of the walls, whilst the normal tissue elements — epithelial and glandular—may have shrunk or disappeared. A similar condition involving more or less all the coats usually occurs with morbid dilatation of the stomach, which is a frequent sequence of chronic catarrh.

The organ is markedly diminished in size in cases of constriction of the cardiac orifice, the walls undergoing a simple atrophy, and also in the condition known as fibrosis presently to be described.

Degeneration.—The inflammatory process involves degeneration of the tissues affected; this as regards the epithelium, columnar and glandular, is granular and mucoid, whilst the muscular tissue when implicated presents the appearance known as cloudy swelling, with later a fatty change. This latter is especially seen in phosphorus poisoning, when the epithelial cells, as well as the submucous and muscular layer, may exhibit extreme fatty degeneration.

The stomach and duodenum may share in widespread lardaceous change, which is almost entirely confined to the blood-vessels of the mucous and submucous layers.

Hypertrophy.—An overgrowth of the normal tissues of the stomach is only to be seen as affecting the muscular coat, and this only within certain limits. It is most marked in the pyloric region, and is determined by conditions which interfere with the normal passage of the gastric contents through the pyloric orifice. When the movements of the stomach are restrained, as by general peritoneal adhesions fixing it to the abdominal wall and elsewhere, the muscular tissue also tends to hypertrophy. Attention has lately been called to a hypertrophied condition of the mucosa of the duodenum and upper part of the jejunum in diabetes.

A very rare, but at the same time perfectly well established, affection is a congenital hypertrophy of the pylorus found in infants a few months old, and leading to death from inanition. The mucosa, and still more the circular muscular ring, is very considerably thickened by an overgrowth of normal tissue, quite distinct from a fibrotic change in the same situation met with at a much later age, though sometimes also spoken of as congenital. Extreme stenosis of the orifice results, with some dilatation of the stomach. The cause of this condition is quite unknown.

Fibrosis; Cirrhosis.—These terms denote an excessive overgrowth of fibrous tissue in the walls of the stomach, which may be partial in extent, and chiefly towards the pylorus, or may involve the entire organ, which in consequence becomes much thicker and of firm, leather-like feel, paler and much less distensible than it should be, and with a capacity diminished to a quarter or less of the normal. In the greater number of cases it is a chronic inflammatory process following on a long-continued catarrh, but it occurs also in cases of corrosive poisoning. This, as already mentioned, is associated with more or less atrophy of the epithelial and glandular elements, and some cystic change in

the latter, which is further increased as the new-formed fibrous tissue in the mucosa develops and contracts, compressing the glands and blood-vessels. Owing to an unequal distribution of the morbid change and irregular contractions of the cicatricial tissue, the mucous membrane is thrown into the most varied thickenings, the surface at places assuming a polypoid appearance, constituting the so-called *état mamelonné*. Unless very advanced the change is chiefly restricted to the mucosa and submucosa, but should it extend into the muscular layer, the contractile fibre cells are likely to be atrophied by pressure of the new-formed material, a result which is also to be seen in the muscularis mucosæ.

In the somewhat rarer cases when the fibrotic change more uniformly affects the stomach, and to which the term "cirrhosis" is perhaps more usually confined, the association with a chronic catarrh is much less constant, and the condition appears to be rather of the nature of a primary overgrowth in the submucous and subserous connective tissue, the determining cause of which is seldom obvious, although alcoholism is apparently responsible for some cases. The mucous membrane suffers less both relatively and absolutely than the other coats, and the muscular coat is usually much hypertrophied.

A general fibroid change, also with hypertrophy of the muscular layer, involving sometimes the entire organ, may be associated with a malignant growth of the stomach, the structural characteristics of which are perhaps best marked or even restricted to the pyloric region, and this is especially likely in scirrhus carcinoma.

Cases are occasionally seen where the fibrous overgrowth is due to an extension of a chronic peritonitis into the subserous and other layers.

An extreme fibroid induration of the pylorus, causing often extreme obstruction, is of not infrequent occurrence, and is by some regarded as essentially a modification of scirrhus cancer, but if this be so, the cases exhibit none of the characteristic clinical features of malignancy.

Gangrene.—Owing to the extensive and freely communicating blood-supply to the stomach, gangrene on any extensive scale is seldom if ever seen. A considerable destruction of the walls has been alluded to as the result of corrosive poisons, and sloughing to a limited extent may be seen in connection with new growths, the vessels of which have been blocked, and also in the phlegmonous variety of gastritis. The digestive power of the gastric secretions upon such of the tissues as have lost their proper vascular-supply is an important factor in the destructive change, and plays a large part in the production of gastric ulcer. Septic emboli, acute yellow atrophy of the liver, gangrenous stomatitis, pneumonia, and acute tuberculosis have been noted as causes of necrotic patches in the stomach.

Erosions of the Mucous Membrane.—Superficial abrasions and destruction of very limited extent—often indeed almost microscopic—may be seen in the course of acute gastritis, or as the result of intense congestion or altered blood states—hæmorrhagic erosions—and may in rare cases be regarded as produced by the mechanical injury of coarse particles that have been swallowed, though the solvent power of the gastric juice is doubtless in great measure responsible. Owing to the readiness with which under ordinary circumstances repair takes place in a mucous membrane, such lesions as these are but of short duration and quickly healed; a slight extension of the process, however, may result in the formation of a distinct ulcer in which the tissue necrosis is more serious.

Ulceration.—Besides the superficial erosions of the mucous membrane just referred to, and those more extensive areas of destruction of the gastric walls brought about by corrosive poisons or other violent irritants that are not immediately fatal, the stomach and the duodenum—at least as regards its first part—are the seat of a very characteristic ulcerative process which is of frequent occurrence, but with a singular difference in sex incidence; for whilst the gastric lesion is far more common in women, especially in young adults, the duodenal affection preponderates in middle-aged males, a fact which suggests that local conditions rather than sexual differences are more concerned in the production of the disease. The actual frequency of gastric ulcer has been variously estimated. From the post-mortem appearances either of actual ulcer or of cicatrix, it has been set down as 5 per cent of all autopsies; some observers have stated the percentage to be much higher.

The ulcer or ulcers, for there may be more than one, either in the stomach only, or both in the stomach and duodenum, present, according to their duration, certain very distinctive appearances. The more recent the ulcer the smaller it is, averaging half to three-quarters of an inch in diameter, of a round or oval shape, with remarkably clean punched outline, with no special thickening of the edges, and the adjacent tissues being healthy in appearance except, perhaps, for a few scattered hæmorrhagic spots. The depth to which the ulcer has extended varies, and the base may be formed by the muscular layer or by the peritoneum, or this may have perforated and communication established with the peritoneal cavity. There is, however, a general disposition for the area of the destruction of the several coats progressively to diminish with the depth to which the necrosis has extended, so that the destruction of the mucosa is greatest, and of the serous membrane the least. In the ulcers of long standing this last character is commonly well marked, so much so as to give a shelving appearance to the area of destruction, the edges

of the several layers being more or less distinct; and to this the expression "funnel-shaped" has been usually, if not very helpfully, applied. Moreover, the edges in this case may be, though not always, much thickened from fibroid growth, but not undermined; the size of the ulcer is generally much larger, attaining a measurement of even five or six inches across in extreme cases, and sometimes of irregular outline. The chronic inflammation associated with the growth of these slowly progressing ulcers, and that is to be seen in the tissues immediately around the edges, tends to cause adhesions of the stomach to contiguous parts, and this in proportion to the fixity of these structures. Hence perforation into the peritoneum is in some measure avoided, and the floor of the ulcer may be formed by the pancreas, the liver, or even the spleen, far less commonly by the abdominal wall owing to its constant movement, and the ulcer is more likely, therefore, to perforate into the peritoneum when situated on the anterior surface of the stomach. But the same accident may happen whatever the situation of the ulcer, and perforation into the pleural or pericardial cavity, or into the post-peritoneal connective tissue, and formation of subphrenic abscess, may occur. Or in this way communication between the stomach and the intestine may be established, and even very rarely into the cavities of the heart. Perforations on both surfaces have been met with. Whilst ulcer of the stomach may be found at any part, it is far more frequent in the pyloric region, and on the whole oftener on the posterior wall. Occasionally the ulcer may extend across the smaller curvature on to the anterior surface. Although the length of time which the ulcer has lasted undoubtedly determines differences in the appearances presented, the writer is unable to recognise that any essential distinction in their nature exists between the two forms here described, and can see no advantage in applying the term "acute" to the former variety, the actual duration of which no data exist for determining, and no clinical justification for drawing such a distinction as the term might imply. Cicatrisation of the ulcer very frequently occurs, and the scar may be seen post-mortem, perhaps in association with a more recent ulcer. Considerable deformity of the organ may result from the shrinking of the scars, especially of those which extend over both surfaces and the lesser curvature, whilst if the pylorus be involved in the cicatrix the orifice may be much constricted.

In offering an explanation for the production of these ulcers, the fact that a healthy mucous membrane successfully withstands the digestive action of the gastric secretions, and that any condition which tends to diminish the resisting power of the tissues favours the necrotic process, must be borne in mind. Indeed, the pathology of gastric ulcer mainly resolves itself into the search for this deteriorating condition, it being fully admitted that the solvent action of the gastric juice is the immediately destructive agent. It is obvious that this action may be at once exerted on a slightly damaged epithelium, whether of the surface or in the glands; but assuming the deeper layers of the mucosa are not implicated in the original damage, whether mechanical, corrosive, inflammatory, degenerative, or other, then the resulting necrosis is limited to the epithelium and a merely superficial erosion is formed. But with a deeper implication a deeper lesion ensues, and ulceration is the consequence. It is probable that the immediate cause is not always the same, although the various conditions that have been suggested are not equally frequent in their activity. The effect in this direction of mechanical or chemical damage of the mucosa is obvious, but few cases are to be thus explained, and still fewer by blows or pressure on the epigastrium, though the latter has been put forward in the case of tailors, cobblers, etc., and in tight-lacing. An impairment of the blood-supply by embolism or thrombosis of the small vessels, thereby interfering with the nutrition of circumscribed areas of the gastric wall, is a possible but certainly not a frequent cause. But it is in this way that minute emboli in pyæmia, or particles that gain an entrance to the circulation as the result of cutaneous burns, may give rise to a few cases of gastric or duodenal ulcer, the gastric juice being the actual destructive agent which exerts its solvent power on the damaged tissues. Endarteritis will also affect the tissue nutrition, and this may explain the alleged liability of the lesion in syphilis as distinct from the ulcerating gumma that has developed in the submucosa. Dr. S. Martin has described a condition which he has termed "bacterial necrosis" due to the invasion of the mucosa or of the gastric glands by micro-organisms, the tissues being from some cause less resistant than normal. It is not suggested that any special inflammatory change follows on the invasion, comparable to that which leads to the ulceration of the intestine in typhoid or tuberculous infection, but that the tissues invaded become less resistant to the peptic digestion, and necrosis and ulceration in consequence ensue. Whilst it cannot be denied that this is the primary cause of some cases, it can hardly be accepted as other than a very occasional condition. Minute fibro-myomata in the submucosa have also been described by the same observer as a rare cause of ulceration of the superimposed mucous membrane by the pressure which the growths exert and consequent impairment of the vitality of the tissue elements. To the writer it appears for many reasons probable that the most frequent cause of this far from rare lesion is the readiness with which a catarrh of the mucous membrane is induced, and with that superficial erosion just

sufficient to give the gastric juice a chance to exercise its digestive action and establish a small area of destruction, which in many cases is prevented from healing by the continued action of the juice and the irritation of food. If, as is often the case, the acidity of the secretion is abnormally increased its destructive power will be greater. The minute hæmorrhages in the submucosa so frequent in the extreme hyperæmic states to which the stomach is subject, by the pressure they exert and the tissue damage they determine, would also appear to be conditions contributing to the same result. Since also gastric ulcer, at least in its commencement, is most common in chlorotic girls, the general malnutrition in such patients renders the resistent and reparative power of the tissues much less than normal, and consequently favours the production of ulcer. It has been sought to explain the occurrence of the lesion by ascribing it to a perverted trophic influence exerted through the vagus, but the grounds for such a view are extremely uncertain.

Lesions of identical character to those so-called "round" or "peptic" ulcers are met with in the duodenum, most frequently in the first part, much less often in the second, and most exceptionally in the third, *i.e.* below the entrance of the alkaline bile and pancreatic secretion. A preference is exhibited for the anterior wall. Sometimes there is more than one ulcer, and a similar gastric ulcer may coexist; the stomach lesion, however, is much more frequent than the duodenal, in the proportion it has been estimated of thirty to one. In origin, appearance, and course they exactly correspond, though perhaps a larger proportion of the duodenal perforate, and a subphrenic abscess is on the whole oftener attributable to the latter than to the gastric ulcer, but healing does take place, and the orifice of the bile-duct may be included in the cicatrix, causing biliary and pancratic obstruction. The chief point of interest about this form of duodenal ulcer is its association with extensive cutaneous burns, an association too frequent to be mere coincidence, records showing about 6 per cent, but much less frequently than was formerly supposed, probably from the greater antiseptic precautions now observed in the treatment of the wounds. It may be mentioned that severe frost-bite has also been known to be associated with duodenal ulceration. It has been suggested that during the inflammatory stage of the burn septic particles gain entrance to the circulation, and as a result minute hæmorrhagic infarctions have been seen in the mucosa of the alimentary canal, the damaged tissue being then dissolved by the gastric juice. Whilst this hypothesis may satisfactorily account for the absence of such ulcers from other parts of the intestine, it does not explain why the duodenum rather than the stomach is the seat of the ulcer, as undoubtedly is the case. For this reason the explanation given of a duodenitis and ulceration due to excretion in the bile of irritants derived from the burned area may be more valid, except that the site of the ulcer is oftener above the entrance of the bile-duct than below.

The occurrence of gastric and intestinal ulceration in the course of chronic Bright's disease occurs with sufficient frequency as to render probable a causal connection, and such ulcers are found in the stomach and duodenum, though less often and less extensively than lower down in the canal. In these situations, when the solvent action of the gastric juice is efficient, the lesions partake of the general characters of the peptic-perforating ulcer.

The softening and ulceration of caseous solitary glands in the stomach and duodenum, and the subsequent enlargement of the ulcer in width and depth by the solvent action of the gastric juice, were regarded by Drs. Perry and Shaw as one mode of origin of the peptic ulcer.

The submucosa may be the seat of syphilitic gummata which may ulcerate, and the vessels of the stomach may exhibit the appearances of endarteritis, in common with those elsewhere. Chronic ulcers with fibrosis of the walls of the stomach are sometimes met with in patients the subjects of syphilis, and in whom similar changes exist in other parts.

The characteristic intestinal lesion of typhoid fever has been occasionally seen in the duodenum in conjunction with ulceration of the ileum and jejunum.

The duodenum may present the œdematous or sloughing patches with petechiæ which distinguish intestinal anthrax, and may be the only part of the canal affected. Much less often is the stomach involved.

New Growths.—By far the greater number of new growths met with in the stomach and duodenum are malignant in character, and exclusive of the uterus, the stomach is the commonest site in the body for development of cancer.

(*a*) *Carcinomata.*—These are almost always primary. Occasionally the stomach is involved by the extension into it of a cancer of adjacent parts, *e.g.* gall-bladder or pancreas, or from the œsophagus.

The sex and age incidence of gastric cancer have been referred to in the section on Etiology.

Structurally the tumours consist of a perverted epithelial overgrowth embedded in a fibrous stroma, and upon the differences in the proportion of these elements, the character and mode of arrangement of the cells, and the destructive and degenerative changes which may take place in the new formation, depend the differences, naked eye and microscopic, which these growths present, and to some extent the varied symptoms they give rise to.

Various terms are applied to the several forms, based chiefly upon their gross appearances. Thus scirrhus growths are those in which the fibrous tissue element greatly preponderates, so much so that the cell elements may require careful searching for. Like all forms of malignant growth they are most frequent at the pylorus, scarcely if at all extending into the duodenum, and along the lesser curvature, but they also tend to infiltrate the body of the organ, and in extreme cases involve the entire viscus, which is thickened to an extent of half an inch or more, causing an extreme shrinking of the stomach and reduction of its capacity to a few ounces; many cases of cirrhosis ventriculi are doubtless of this nature. The fundus is least often the site of a malignant tumour.

In the medullary variety the growth is much softer, grows more rapidly, and forms extensive polypoid excrescences into the cavity of the stomach. In these the fibrous stroma is at a minimum, and the abundant cells are clustered in groups or assume a distinct tubular arrangement not unlike that of the gastric glands, although later, as the tubules become crushed and displaced, this arrangement becomes less obvious. These so-called "cylindrical carcinomata" pass by insensible gradations into what are known as "adeno carcinomata" or "destructive carcinomata"—the term "epitheliomata" being collectively applied to all. With this form there may also be a very considerable infiltration of the stomach walls besides the massive outgrowths. Owing to their physical characters and rate of development it is the medullary cancer which is most prone to ulcerate, and also as a consequence to bleed. Portions of the surface may be seen in a sloughing state, and with the continued formation there is a continued destruction of the growth, even to leaving large ulcerating areas with considerable induration and very thickened edges.

The carcinomata that commence at or are confined to the cardiac region are sometimes of the nature of squamous epithelioma, such as are met with in the œsophagus; others are of the spheroidal variety, such as occur in other parts of the stomach. In this condition the stomach generally atrophies and shrinks, the œsophagus being dilated.

These various growths are very liable to undergo a colloid degeneration, both of cells and stroma. To a slight degree it is frequent, but occasionally the change assumes a most extensive character, and gives rise to large alveoli enclosing gelatinous material, which spread to the peritoneum and thence to the abdominal cavity generally.

Primary gastric carcinoma starts in the mucosa or submucosa, and later invades the muscular, subserous, and serous layers, together with a leucocytic infiltration, especially in the medullary varieties. To what extent a previously deteriorated or damaged state of the constituent epithelial tissues favours its origin is unknown, and in some measure depends on the view taken of the determining cause of the neoplasm, but it is noteworthy that the orifices, especially the pyloric, where the opportunity of friction from the contents is greatest, are the most frequent situations, corresponding in this respect to the growth of cancer elsewhere. Some stress has been laid upon the frequency with which a chronic ulcer, or the scar thereof, may become the seat of a malignant growth; but the relationship of these conditions is probably no more than that of a damaged surface favouring the development of the new growth, or, on the infective view of the origin of the latter, facilitating the invasion of the organism. But in reference to this question the clinical fact that cancer of the stomach very often develops in persons who have given no previous evidence of gastric derangement of any kind must be remembered. When the serous membrane is involved an adhesive peritonitis is set up, sometimes to a considerable extent, the gastric growth being inextricably involved in a mass of fibrous tissue by which the surrounding parts are matted together. This is especially so when the neoplasm has originated outside the stomach, as in the gall-bladder. It may be observed that tuberculous lesions have frequently been found in the bodies of persons dying of cancer of the stomach, as previously stated.

The lymphatic glands along the lesser curvature are involved, and may attain a considerable size: the retroperitoneal, and occasionally the inguinal, supraclavicular, and maxillary glands may also be enlarged.

Secondary growths are more likely to follow on the medullary forms, which are more vascular, and from which particles are more easily detached into the blood or lymph current. Obviously the liver is the commonest seat of such deposits, and less often the lungs. Subcutaneous nodules, especially around the umbilicus, are occasionally seen. Involvement of neighbouring organs—liver, peritoneum, pancreas, colon, etc.—by extension is common, and in this way fistulous communication of the stomach into the intestines may be established.

The duodenum, and more particularly the second part, is an occasional seat of primary carcinoma that accords in general characters and course to similar gastric growths. It is by far the most common situation for malignant tumours of the small intestine, and is frequently involved in extensions of growth from the pancreas or pylorus or gall-ducts. It almost always causes stricture of the gut. As in the stomach, the scar of an ulcer appears to be not infrequently the starting-point of the new growth. As Dr. Rolleston has pointed out, "carcinoma has a special tendency to arise in the duodenal mucous membrane covering the

biliary papilla. This must be differentiated from carcinoma arising inside the papilla or in the ampulla of Vater." And he further adds that the former may be rapidly fatal by causing suppurative inflammation of the bile-ducts.

Malignant nodules in the stomach and duodenum, *secondary* to similar growths in the heart or elsewhere, are not unknown; Dr. Hale White says 6 or 7 per cent of all malignant gastric neoplasms are in this category.

(*b*) *Sarcomata.*—New growths of this type occasionally occur both in the stomach and in the duodenum, presenting in their general features a close resemblance to the carcinomata. They are of the round cell variety, and have been noticed especially to invade the muscular coat, spreading from the submucous (Drs. Perry and Shaw). As a rule, they occur at a much younger age than does carcinoma, very many being in persons under twenty years old.

(*c*) Small *fibro-myomata*, *lipomata*, *and papillomata* have been recorded as of rare occurrence, and the same may be said for the development of lymphadenomatous nodules as a part of a general lymphoid overgrowth.

Malformations and Malpositions.—These departures from the normal condition may be either congenital or acquired. On the whole, the stomach is less liable to those of the former class than are many other organs.

Complete absence of the viscus has been recorded, the continuity between œsophagus and intestine being completely interrupted. A stomach congenitally small, or with partial separation into two parts by septa, has been met with, and also a peculiar condition of pyloric stenosis from hypertrophy of the muscular ring.

The deformity known as the "hour-glass contraction" appears to be sometimes congenital, and has been regarded as a reversion towards the condition in some lower animals. Atresia of the duodenum by a septum resembling a large valvula connivens near the biliary papilla, or at the junction with the jejunum, is an occasional condition, and occlusion of the bowel in all degrees up to completeness may be met with.

These organs may share in a general transposition of the viscera, or the stomach may be situated in the chest from absence or deficiency of the diaphragm. In the fœtus and at birth the stomach is more vertical than in the adult, and this position may be maintained during life, though probably not so often as has been supposed.

Acquired deformities and displacements of the stomach and duodenum are far from uncommon. Owing to the cicatricial contraction which may follow ulceration the viscus may be considerably distorted, especially when the lesion has affected the walls to any depth, and no adhesions have taken place to adjacent organs. The internal surface may be much puckered by radiating cicatrices, or the organ may be constricted in the middle, causing the "hour-glass stomach," with consequent dilatation or contraction of the two parts into which the cavity is divided. Such a deformity when once established is, of course, permanent, and must be distinguished from a temporary condition, which may be sometimes seen post-mortem, due to a spasmodic contraction of the "pre-pyloric sphincter," corresponding to what normally takes place during digestion.

The shape of the stomach is also much altered in advanced cases of cirrhosis ventriculi, or of general infiltration of the walls by new growth. In such the normal pyriform outline is lost, and the shrunken organ is more tubular in character and much diminished in capacity. The stomach may be very much reduced in size subsequent to permanent œsophageal obstruction. Stenosis of the pyloric orifice is of frequent occurrence, caused by the cicatrix of an old ulcer situated in that region, or by a new growth, or less often by a non-malignant fibrosis or hypertrophy of the pyloric valve.

Dilatation of the Stomach; Gastroectasis.—This is the commonest and clinically most important of the alterations in shape and size to which the stomach is liable. Whilst in a few cases apparently primary in origin, it is far more usually secondary to some definite gastric disease, and of these pyloric or duodenal obstruction, from whatever cause, is the most frequent. The difficulty and delay in forcing the stomach contents through into the duodenum leads to their accumulation within the organ, the muscular coats of which may hypertrophy, particularly in the pyloric region. But this compensatory change is only possible to a limited extent, and should the cause of the stenosis be a carcinomatous infiltration the muscular tissue is displaced by the new growth, and the propulsive efforts proportionately fail. The undue retention of the partially digested food in the stomach soon leads to a catarrhal state of the mucous membrane, which diminishes the general tone and resistance of the stomach walls, and contributes to their yielding, which the bulk of the contents and the gases formed by their fermentation still further assists.

Next in frequency as a cause of gastroectasis is a weakening of the stomach walls, such as follows on a chronic catarrh, and occasionally on an acute attack of the same condition. A too frequent ingestion of food—a habit acquired by many persons—has been held as a cause of gastric dilatation. Should there be, as is likely, from the impaired digestion a state of general malnutrition, or any debilitating disease, such as anæmia, chronic renal disease, etc., the resisting power of the stomach walls will be still further diminished, and so favour the dilatation of the organ. The dilatation in these

two groups of cases usually takes some time, weeks or months, to be established; but there is sometimes met with an acute form of this condition, the cause of which is often obscure. To this category belong those cases of gastroectasis which develop in connection with some of the acute infective diseases, when the walls of the stomach may be supposed to be weakened by the toxic substances produced in the course of these maladies. Similar acute dilatation which sometimes occurs in nervous states, such as hysteria aud neurasthenia, are far less easy of explanation. A large secretion of fluid, amounting to several pints, is usually found in these acute cases.

The extent to which the stomach may distend from these various causes is very variable, though occasionally enormous—three or four times the normal capacity. With this extreme enlargement the organ tends to fall in the abdomen, the upper part of which it nearly fills, and the lower margin may reach almost or quite to the pubis, bending upwards from the right iliac fossa towards the duodenum, which remains, except perhaps for the first part, almost constant in position. In other and less extreme cases the stomach lies transversely across the abdomen from left to right hypochondriac region, with the lower limit somewhere below the level of the umbilicus; and in exceptional cases the dilated viscus chiefly occupies the left side of the abdomen, being more vertical in position. These displacements downwards are most marked when the cause is an obstruction at the pylorus, and the greatest distension is associated with non-malignant stenosis. In the enlargement from atony the stomach seems rather to dilate upwards (Broadbent). Except for such thickenings as may be due to new growths, and hypertrophy of the muscular layer, the walls of the dilated stomach are much thinner than normal, though rupture is of doubtful occurrence except there be previous ulceration or injury.

In great eaters, and particularly when the food is chiefly vegetable, the stomach may exceed its normal size and capacity, but so long as there is no undue delay in the emptying of the viscus the condition is not to be clinically regarded as one of disease.

Dilatation of the stomach and displacement of the right kidney have been noted as frequently coexisting.

As the result of obstruction in its lower part the duodenum may become enormously dilated, the stomach being commonly also involved. The duodenum also appears to exhibit a special proneness to become sacculated as compared with the rest of the canal, and Drs. Perry and Shaw have suggested that this may be due to "an unusual degree of intra-intestinal pressure in this part of the alimentary tube." The base of an ulcer in this situation may yield and give rise to a diverticulum, or the bowel may be dragged on from outside by adhesions, forming "retraction sacculi." Sometimes no such cause is to be discovered. Occasionally, two saccules may be met with, preferably in the neighourhood of the biliary papilla. The pouches are lined by a normal mucous membrane, which is wanting when there has been a previous ulcer, and are formed by all the coats, being about an inch in diameter. Sometimes the sac consists of a protrusion of the mucosa between the separated fibres of the thinned muscular layer, and covered by the peritoneum.

The various causes of pyloric stenosis have been incidentally referred to, and may be collectively enumerated thus: (*a*) congenital, (*b*) fibroid overgrowth, malignant and non-malignant, (*c*) growths in the pyloric region, (*d*) cicatricial contraction of scar following ulceration, (*e*) pressure of growth from without, (*f*) displacement of pylorus by adhesions or by dilatation of stomach, causing kinking of the duodenum and functional constriction of the pyloric orifice, the so-called "stenosis by dislocation."

Gastroptosis.—Besides the alterations in position assumed by the stomach in consequence of its increase in size, the organ may "drop" from its proper situation as a part of a general ptosis of the abdominal viscera, and less frequently may alone be so displaced. Deformities of the trunk from spinal curvature, tight lacing, etc., may also lead to some change in position of the viscus, which in these cases is otherwise normal.

As the result of adhesive peritonitis the stomach may become fixed by firm fibrous adhesions to the diaphragm, abdominal wall, spleen, and other structures, and some distortion of the organ may result therefrom.

Rupture of the healthy stomach or of the duodenum may be the result of injury, blows over the epigastrium, especially when distended by a meal, or being run over by a wheel. The existence of ulceration may favour the accident. Laceration of the duodenum has also been attributed to severe and prolonged vomiting.

Fistulous communications between the stomach or duodenum and adjacent parts may be established by morbid conditions originating in the latter. Thus the gall-bladder or colon may ulcerate through into the duodenum, or abscesses in various situations, hydatid cysts, or aneurysms may burst into the stomach or bowel.

Various foreign bodies that have been swallowed, or that may otherwise have gained entrance into the stomach or duodenum, may be found therein. Masses of hair, string, coco-nut fibre, etc., felted together, pins, nails, etc., have been seen in the stomach in lunatics or hysterical patients. Gall-stones may lodge in the duodenum, and ascaris lumbricoides is sometimes to be met with as high up in the canal, whilst

it is the normal habitat for the ankylostoma duodenale.

General Symptomatology

The various morbid structural conditions above described determine the occurrence of certain signs and symptoms, some of which are more or less common to all stomach affections, as others, whether singly or in combination, are more peculiarly distinctive of individual lesions. But besides these definite diseases of the stomach and duodenum, with the manifestations they give rise to, there are many phenomena which are referable to improper digestive changes in these organs which may have been caused by circumstances quite apart from the viscera concerned, and that are properly those of indigestion or dyspepsia. No doubt primary digestive disturbances that may be set up in the stomach, and not directly due to diseases of the viscus itself, will sooner or later bring about morbid changes in the organ, and a vicious circle be established; and on the other hand, primary affections of the gastro-intestinal tissues will, in addition to the indications furnished by their existence, also tend, in proportion to their severity and continuance, to set up indigestion. It is not, therefore, sought to attempt any sharp distinction between the clinical phenomena due to the structural lesions and those attributable essentially to the ill-digestion of the contents; but in forming a diagnosis and proposing a treatment it is desirable, so far as possible, to keep these two fundamental sources of symptoms distinct, and to discriminate between what is dyspeptic or functional trouble and actual structural lesion.

The subject of indigestion, at least so far as the stomach is concerned, has already been considered (*see* article "Indigestion," vol. iv.). Inasmuch as digestion properly signifies the physico-chemical changes which take place in the food in the alimentary canal, it seems to the writer undesirable and inaccurate to include in its purview the function of the absorption of the digester, and still less the phenomena of metabolism which concern the destination, changes, and uses of the absorbed material, and for imperfections in which neither the digestive organs nor the process of digestion may be in any way responsible. Hence "indigestion" or its synonym "dyspepsia" is here taken to mean some imperfection in the digestive process as above defined, whether it be oral, gastric, or intestinal.

The signs and symptoms of structural diseases of the stomach and duodenum, together with those referable to mal-digestion of their contents, whether there be obvious lesions of these organs or not, may be conveniently grouped into (*a*) local and (*b*) remote. With respect to the former it is certain that they are present in a greater or less degree whatever may be the character of the cause, and in the more pronounced and graver structural affections they may almost be regarded as paramount, the remoter manifestations being in the greater number of cases scarcely existent. On the other hand many dyspeptics, in whom the condition is chiefly functional, with little if any recognisable change in the stomach, manifest symptoms which are in a great measure distant from the organs in which the faulty process is at work. At the same time it is not suggested that it is possible to draw therefrom a symptomatic distinction between the organic and the properly functional diseases.

The local symptoms of gastric or duodenal disorder are separable into (*a*) subjective sensations and (*b*) objective phenomena.

The process of digestion is normally carried on without any conscious sensation thereof, and the only sensory impressions connected with the process are a feeling of hunger referable to the stomach, which may in some cases become painful in its intensity, and the sense of pleasurable well-being which follows on the healthy gratification of the appetite. This last, however, is rather of the nature of a general sensation than in being specially associated with the stomach; similarly the sensation of thirst is of a general character, probably connected with a want of fluid by the tissues, and though perhaps most felt in the pharynx, really originates in the nervous centres. Perversions of these sensations—hunger and thirst—are among the commonest symptoms of disordered digestion, and also in some measure of structural diseases of the stomach. They have received special consideration in the article "Appetite" (vol. i. p. 256).

The strictly local sensory affections accompanying indigestion and gastro-duodenal diseases exhibit the widest range of degree and character. The channels by which they are probably conveyed to the sensorium have been mentioned in the section treating of the anatomy of these organs. The generally accepted terms in which these sensations are conventionally described are for the most part very inadequate, but the limitations of language in this respect offer no better alternatives. Vague discomfort referred to the gastric region, a sense of "weight," "fulness," "tightness," or "oppression," or a "sinking" feeling before or after food, are some among those most frequently complained of, and are oftenest attributable—at least the three first named—to a larger bulk of contents, whether solid, liquid, or gaseous, than the stomach can cope with, whether this has been due to a larger meal than was suitable to the individual, or to the development of gases during the process of digestion, or to the presence of some specially indigestible article of food. Speaking generally, such symptoms are an expression of a delayed digestion,

whether from insufficiency of the gastric juice, or from impaired motility of the organ, as in gastroectasis or atony from whatever cause, or from both. A feeling of "emptiness" akin to hunger is, as the word implies, commonly due to a want of food in the stomach, which may be the result of a very rapid digestion and expulsion of the digesta into the intestine, coming on unduly soon after a meal. The nature of all these sensations and of pain, next to be considered, is clearly related to the sensibility of the stomach. Normally this appears to be but slight, less so perhaps than in the intestine; ordinarily, hot or pungent substances swallowed produce no conscious effect when they reach the stomach, and moderate irritation of the gastric mucous membrane seems to cause a sensation of "weight" rather than pain (Brunton). The mucosa, however, is liable to become hyperæsthetic, and then pain is experienced.

Pain in the stomach, *stomach ache*, or *gastralgia* is the most marked, the most constant, and in some respects the most distinctive of gastric symptoms, indicating some structural change of the organ of primary origin, or an irritation due to some digestive disturbance, or some purely neuropathic condition.

The epigastrium and lower end of the sternum is the most frequent situation of pain of stomach causation, this being often strictly circumscribed, and perhaps felt over an area that may be covered by the finger tip, in other cases it is more diffused over the epigastric and hypochondriac regions. Less often than intestinal and other abdominal affections it is experienced about the umbilicus. Owing to the course of the afferent nerve channels, the pain is frequently referred to the interscapular region and to the shoulder, whilst the overlapping of the pulmonary and gastric nerve-supply accounts for the occasional reference to the stomach of pain that is excited by diseased states of the lungs or pleura.

In character the pain varies from a dull ache or sense of weight and tightness to being "throbbing," "spasmodic," "dragging," "gnawing," "darting," "lancinating," "smarting," "burning," or a sense of "soreness," of all degrees of intensity, from simple uneasiness up to intolerable agony. The milder forms may become wearing out when long continued. It is noticeable that patients rarely if ever use to describe their suffering such similes as being "gnawed by a rat," or that their "insides are being burned with red-hot irons," as they not infrequently do when the lower intestines are the source of the pain; and that gastric pain, whatever be its character, is less likely to provoke mental delusions than intestinal distress is. The duration of the discomfort may be extremely brief or almost continuous. It is seldom that the pain has any reference to the mere quantity of the ingestion, but the quality of the same is apt seriously to influence it, and the simplest articles of diet may in some circumstances provoke great distress. Curious idiosnycrasies in this respect are to be met with. The time relation of the pain to the taking of food, whether it follow immediately or not for half an hour, or one or two hours, and to what extent it is relieved by vomiting or by the eructation of gases, or whether it be increased or diminished by pressure over the stomach, are also characters to be noted, as well as the presence or absence of tenderness over the painful area, which is sometimes so great as to prevent contact with the clothes. To some extent these several characters of gastric pain are distinctive of the various diseased states which the stomach may exhibit, and so far are referred to in treating of the special symptomatology of these maladies; and although, taken with other indications, they are of considerable diagnostic value, yet they require judgment for their interpretation owing to the exceptions which must be made in any statement concerning them. It is also important to remember that pain in the situation and with the characters here described may be due to causes other than gastric, such as affections of the colon, spleen, gall-bladder and ducts, spinal caries, thoracic aneurysm, and intercostal neuralgia.

As Dr. Head has shown, certain regions of the scalp are associated with the segmental areas of the trunk as low as the tenth dorsal, it follows that reflected pain and tenderness may be experienced over the temporal, vertical, parietal, and occipital regions when the areas corresponding to the stomach, viz. seventh to tenth dorsal, are involved, and as discomfort over the latter varies in intensity, so will the former.

A peculiar form of gastric pain is known as *heart-burn*, *acidity*, or *cardialgia*, caused by the contact of the acids of the stomach (whether the hydrochloric or the organic acids produced during digestion) with the surface of the œsophagus, which is normally much more sensitive than the stomach. The condition which permits this contact is a relaxation of the cardiac orifice with slight eructation of the stomach contents. It is usually associated with gastric flatulence, which favours this regurgitation, and is relieved by free eructation, or by assuming the erect position It is not to be regarded as necessarily indicative of hyperchlorhydria nor of increased acid fermentation, and often is not so.

Closely connected with unhealthy states of the stomach and its contents are a *foul breath* and *nasty taste in the mouth*, of which there are many varieties. Ill-smelling gases liberated in the process of digestion, some of which have escaped upwards from the intestines through the pylorus, account for the first, and in some measure for the second, which is also partly due to abnormal products of digestion or of meta-

bolism which are excreted in the buccal fluids. The condition of the mouth itself, carious teeth, etc., must not be overlooked in this connection.

Another subjective sensation is *nausea*, which is especially likely to be called forth by the sight or thought of food, or may be felt apart from such association. It is always combined with an impaired appetite, and readily passes on to vomiting. It is usually due to some altered state of the mucous membrane of the stomach, and is hence a frequent though not invariable symptom of catarrh both acute and chronic, but its precise pathology is not certain.

The chief *objective signs* of gastric disease, besides such as are ascertained by physical examination, are flatulence, eructations, and vomiting.

Flatulence.—The stomach ordinarily contains a small amount of gas, partly consisting of air that has been swallowed, and partly of CO_2, derived from fermentation of the food-stuffs. From either of these sources the amount may be very considerably augmented, and in addition gases, such as CO_2, H, SH_2, and even CH_4, may pass upwards from the intestines through a relaxed pylorus. Under certain conditions, not well understood, an interchange between the gases of the blood and those in the stomach may take place in such a way as largely to increase the latter. When the quantity in the stomach is such as to cause distension, or is eructated in appreciable amount, then flatulence is understood to occur. Since the fermentation of carbohydrates is the chief cause of the condition, it follows that it commonly indicates such an error in their digestion as permits a longer delay of the food in the stomach than should be, or a deficiency of hydrochloric acid by which the fermentations are held in check. Other forms of mal-digestion, however, are sometimes responsible, and paralytic distension of the organ, as may occur in some nervous states, after great pain or with peritonitis, is associated with an extreme amount of flatulence. Apart from the discomfort and even pain induced by the distended stomach, disorders of the circulation, such as fainting, palpitation, and pseudoanginous attacks may ensue, consequent on the impediment offered to the heart's action.

Eructations.—Besides the belching up of gases, which may be sometimes very distressing in amount, coming on an hour or two after meals, or much later, some of the liquid contents of the stomach may be brought up into the mouth. These may be neutral or alkaline (water-brash), consisting generally of saliva that has been swallowed, or of the fluid remains of digestion in which the acids have been neutralised or reabsorbed. Or, as is more common, the ejecta are acid (pyrosis), whether hydrochloric or organic, and frequently associated with hyperchlorhydria, and as a consequence give rise to cardialgia. Such fluid may rise into the mouth at any time after a meal, but more often about one to three hours after. When not due to hypersecretion, it signifies some delay in the digestive process, and in the propulsion of the chyme into the duodenum.

Vomiting.—Next to pain this is probably the most significant sign of gastric disorder, but it must be remembered that it is induced by conditions quite apart from the stomach, as in some cerebral and meningeal diseases, certain blood states and poisonings, and in a reflex manner. When strictly dependent upon local causes, these are to be found in the nature of the food, quantity or quality, an irritable state of the stomach from catarrh or ulceration, the former of which occurs in most gastric diseases, and hence vomiting comes to be a very frequent manifestation of stomach affections. Its time of occurrence and relation to the ingestion of food, the relief or otherwise it may bring to discomfort or pain, whether it be easy of performance or accompanied by much retching and straining, are among the chief characters to be taken notice of. Still more informing is the nature of the vomit, such as the quantity and appearance, its reaction, and the nature and percentage of the acids present, the condition of the food-remains, and the presence of bile or blood—points that are fully dealt with in the account of the individual diseases (*see* article "HÆMATEMESIS," vol. iv. p. 13).

Inasmuch as the digestion which takes place in the stomach is in the main preparatory to the more elaborate changes which take place in the intestines, it is obvious that the latter are liable to be influenced by the completeness or otherwise with which the stomach performs its functions, and hence such peristaltic disturbances as constipation and diarrhœa, although directly dependent upon the intestines, may really owe their causation to gastric inefficiency.

Space precludes more than the bare enumeration of the REMOTE SYMPTOMS of gastric indigestion, which may be thus grouped. *Nervous.*—Headache, vertigo, giddiness, subjective sensations of sight and hearing, drowsiness, heavy sleep, torpor, wakefulness, mental irritability or depression, hypochondriasis, melancholia, referred pains, muscular cramps. Dr. Ford Robertson has recently drawn attention to severe catarrhal changes in the stomach and intestine associated with various forms of insanity, especially general paralysis, and attributes the lesion in the mucosa to the irritant effects of toxic bodies developed during digestion. *Circulatory.*—Palpitation, cardiac irregularity, intermittent action, syncope, cardiac pain, angina, flushing of face, coldness of extremities. *Respiratory.*—Cough, dyspnœa, sighing. *Cutaneous.*—Various urticarial and erythematous rashes, acne, muddy or dirty complexion. *Urinary.*—Deposits of urates, phosphates, oxa-

lates, uric acid; albuminuria; glycosuria; aromatic sulphates. Among the most frequent results of diseases of the stomach, or other organs of digestion, and of disorders of the functions performed by them, are a general malnutrition, as seen in the wasting and emaciation which so frequently follows on these maladies, and a deteriorated resisting power on the part of the tissues, rendering them more susceptible to infections (*e.g.* tuberculosis) or other causes of disease.

Of the interference with digestion by the inadequate absorption of digesta from the stomach, or by the presence of substances excreted into the viscus, as may be the explanation of "gouty dyspepsia," very little is known; but it is not improbable that either condition occurs independently of the other and commoner causes of indigestion.

Such are the manifestations of gastric disease and of gastric dyspepsia considered generally. Covering as they do so wide a range of character, their investigation becomes difficult so far as their reference to cause and diagnostic value are concerned, from the fact that many totally different conditions give rise to similar symptoms. Groups of these occurring in association with tolerable uniformity constitute the several varieties of indigestion which have been qualified by such terms as "irritative," "atonic," "flatulent," "bilious," etc.—names which it is now better to discard, as a more precise pathology has shown their inaccuracy. Far less open to objection is a classification based on the site of the digestive perversion, whether oral, gastric, duodenal, or intestinal, although the data for such a grouping are still very deficient. From another aspect the forms of dyspepsia may be arranged according to the particular element of the food which is ill-digested—proteid, fat, or carbohydrate. But probably the most satisfactory basis is that of causation, which would give the following forms: (i.) Dietetic; (ii.) Symptomatic, *i.e.* the manifestation of primary affections of the digestive organs — structural, nervous, and vascular; (iii.) Bacterial indigestion; and those rarer conditions due, it may be presumed, to (iv.) Defective absorption of the digesta, and to (v.) Improper excretory processes taking place in the gastro-intestinal canal. Restricting attention, however, to the stomach and duodenum, it suffices to repeat that symptoms distinctly referable to these organs are due—(1) either to structural diseases of those viscera, or (2) to abnormal digestive changes taking place in their contents, and that these last may be the result of (*a*) structural defects, or (*b*) may be the consequence of dietetic errors, or (*c*) of some impaired nervous control of the function without any recognisable lesion in the organs concerned, a true nervous dyspepsia. But although these three fundamental forms—symptomatic of structural disease, dietetic and nervous—may each occur in many varieties, yet the continuance of the second and third is likely to bring about from the irritation produced some change (catarrhal or other) in the mucous membrane, which intensifies the primary fault.

Special Symptomatology and Treatment of Gastric Neuroses

Included within this term are those disturbances of gastric function for which no structural cause is to be found in the organ itself, and attributed to perverted nervous influence, whether this be due to gross change in the nerve centres, such as tabes dorsalis, cerebral tumour, meningitis, etc., or to general states of these centres for which no anatomical substratum has as yet been discovered, such as hysteria and neurasthenia, or that still more indeterminate condition known as the "nervous temperament." By far the greater number of cases are referable to these last-named causes, whether they have been inherited, as is more usual, or have been acquired as the result of excesses in living, of nervous exhaustion, of chlorosis, of gout, of previous illnesses like influenza, or of other circumstances. Not a few may be traced to causes acting reflexly, especially pelvic disease, ovarian, uterine, or rectal, and even, it has been asserted, to eye-strain and astigmatism.

The influence of the nervous system is exerted on the sensory, motor, and secretory functions of the stomach, and perversions of each of these are met with singly or in combination. Whilst some are quite independent of morbid changes in the organ, some are also met with in association with very distinct lesions, but no appreciable difference is to be detected in the symptoms in these two groups of disease.

Secretory.—Although the anatomical connection between the nervous system and the gastric glands is as yet imperfectly known, the control exerted is undoubted. Under normal circumstances it may be affirmed that the gastric juice is only secreted under the stimulation of food, or immediately preceding its ingestion when mastication is about to commence, and that in the intervals between gastric digestion, except for any mucus or swallowed saliva, the stomach is empty, and, also, it would appear that the presence of the gastric secretion in an empty stomach is productive of pain or discomfort of some kind. Further, it seems to be very probable that the quantity and quality of the gastric juice are very considerably influenced by the mental or emotional state of the individual, and possibly the existence of pain may act similarly. Thus it may be that food that departs widely from physiological digestibility may be taken with impunity by a dyspeptic under pleasurable surroundings, whilst a per-

fectly orthodox diet may provoke indigestion under conditions of depression or anxiety. The effect on the motility as well as on the secretion of the stomach is not to be disregarded in the result.

Investigations, more especially in Germany, have gone to show that the secretion of the gastric juice is subject to very considerable variation both as regards quantity and time of production in relation to food ingestion. It cannot be said that in this country these results have received much clinical application, in great measure from the obvious difficulties connected with the withdrawal and analysis of the stomach contents under specified circumstances, more especially since such procedures require frequent repetition to obtain a knowledge of the real state and to avoid a general inference from a possibly chance condition.

The alterations in the composition and quantity of the gastric juice at present recognised chiefly concern the hydrochloric acid; of the pepsin and other ferments less is known, but they do not in all cases appear to vary *pari passu* with the acid.

Thus it is found that the quantity of gastric juice secreted may very much exceed the normal, being poured out either almost continuously (Reichmann's disease), or at intervals quite irrespective of the presence of food in the stomach. Very frequently the fluid contains a greater percentage of hydrochloric acid than in health. These conditions are for the most part met with in grave nervous states, such as the enormous secretion in the gastric crises of tabes, often lasting over several days, or the similar state observed in the rare and obscure cases of acute gastric dilatation which are usually rapidly fatal. They often appear to be quite unconnected with any obvious lesion of the stomach.

In another group of cases of more frequent occurrence the percentage of hydrochloric acid exceeds the normal (·1 to ·25), and may be as much as ·4 or ·5, with no increase in the quantity of fluid. This hyperchlorhydria is a frequent accompaniment of chlorosis, and is constantly associated with gastric ulcer, with the production of which it is largely connected. Another cause for hyperacidity, quite distinct in character, is an over-formation of organic acids derived from fermentation of the carbohydrate ingesta—a true digestive fault—which is rendered possible by a deficiency in the hydrochloric acid secreted, or by a great excess of sugars and starches. It is important to recognise the difference in the nature of these two conditions, which may appear to be alike to the mere test of litmus paper.

In contrast to the foregoing are those patients in whom there is a deficiency of gastric juice, even, it is said, to complete suppression—achylia gastrica—or a percentage of hydrochloric acid below the normal. Although these conditions may occur without any change in the mucosa, and may be the effect of nerve influence only, they are most frequently the result of the chronic catarrhal, or other alterations in the structure of the mucous membrane when the glands are destroyed, such as is particularly found in cancerous infiltrations or in cirrhosis ventriculi.

The symptoms which these several morbid states give rise to are necessarily closely associated with imperfections in digestion, and are in some measure modified by any coincident alterations in the motility of the stomach. All degrees of sensory disturbance are experienced, from a mere sense of weight and fulness, or vague abdominal discomfort, when the secretion is deficient, to a burning pain when the acid is in excess, or the juice is poured out into an empty stomach. Acid eructations and gaseous expulsions are frequent, and vomiting generally gives relief, though causing a smarting in the gullet from the nature of the ejecta. In hypersecretion and hyperchlorhydria the appetite is often good, and frequently food relieves the pain, particularly if this be nitrogenous, by combining with the acid, but in the reserve condition the desire for food is variable, capricious, or wanting. As a rule, the symptoms supervene soon after a meal, when the secretions are deficient, and perhaps not for two or three hours, when there is excessive acidity.

Owing to the very inefficient digestion of the food when the juice is deficient, the remote digestive troubles such as lassitude, headache, etc., are commonly complained of, and the case corresponds generally to a chronic gastritis, which indeed may be the cause. In excessive secretion, so long as there is food to deal with, symptoms are for the most part in abeyance, since digestion of proteids at least is effected, and the evils of excessive carbohydrate fermentation are averted; but when the stomach is empty, then the superacid fluid acts as an irritant on the mucous membrane, which, there is reason to suppose, is often hyperæsthetic in such cases. As further contributing to the pain that is felt, pyloric spasm is liable to occur, being excited by the over-acidity. Irregularities of the bowels, constipation, or diarrhœa are almost surely present. Regard must also be paid to other manifestations of the underlying neurosis, which may or may not overshadow those referable to the digestive organs.

There is little to add concerning the *sensory* neuroses of the stomach, to what has already been written about perversion of appetite, pain, nausea, and other abnormal sensations. No distinction can be drawn between those associated with definite gastric lesions and the same when no structural change is to be found and they are the expression of some general neuropathy or of a local neuralgia (gastrodynia). Such symptoms play an important part in the

manifestations of "nervous dyspepsia," and are not infrequently relieved by the taking of food, or by pressure over the epigastrium, although this is not invariable. Having regard to the normally slight sensibility possessed by the gastric mucosa, a condition of hyperæsthesia is assumed to exist when the presence of food, of saliva, or of stomach secretion induces pain or distress, and such a state appears to be the explanation of much of the discomfort associated with erosions, ulcer, and indeed of structural changes in the stomach generally. From this it will be seen that it is often extremely difficult entirely to exclude the existence of any lesion in a case of gastric pain and to be sure that it is a gastrodynia only. Attention should be paid to the presence of other hysterical or neurasthenic symptoms and to relation of the pain to other evidences of disordered stomach, such as vomiting, cardialgia, flatulence, tenderness, etc., as well as the results of physical examination of the abdomen. The occurrence of pain independently of food, or its relief by the same or by pressure, and a general tendency to periodicity in occurrence, often regularly at night, and little disposition to be referred to the interscapular region or shoulder, are of considerable importance in arriving at a diagnosis. The most frequently recurring difficulty in respect to diagnosis lies in the discrimination of these very common cases in chlorotic young women, when all the symptoms of gastric ulcer are present except the hæmorrhage, from what would be regarded by many as gastrodynia, and it may be admitted that no criteria of difference are to be found, nor are such reasonably to be expected if much of the pain in ulcer is attributable to hyperæsthesia of the mucosa. Paroxysms of gastrodynia are occasionally alarming in their intensity, for with the pain there may be a condition almost of collapse, with cold sweats and a small slow pulse, though this does not always correspond to the general condition, and may give a clue to the real nature of the affection. A copious flow of pale urine of low specific gravity, as with other forms of nerve storms, may immediately follow the attack. A curious and inexplicable association of gastric pain with aortic incompetency has been noted. As illustrating pain of nervous origin, when there is a gross lesion of the centres without change in the stomach, may be mentioned the gastric crises of tabes. The condition known as "anorexia nervosa," when a most extreme emaciation takes place, often with complete loss of appetite, is not to be regarded as merely the result of a want of food or a peculiar form of gastric neurosis, but rather as some abnormal state of the central nervous system, which leads not only to impaired appetite (not always, it is to be noted, a complete anorexia), but also to a grave deterioration in the nutritive capacity of the tissues.

Perversions of the *motility* of the stomach are frequent and various, both in the direction of excess and of deficiency; and their dependence on impaired nervous control, distinct from gastric disease, is in very many cases undoubted, emotional and mental states being often clearly responsible. All grades of excess are to be met with, from an increased peristalsis up to an attack of eructations or vomiting—so-called hysterical—which may last for days. The intestines are at the same time usually involved, and borborygmi and diarrhœa occur, causing much inconvenience. The sensibility of the stomach is also most likely to be altered, and the motor disturbances are then accompanied by a conscious sensation of the existence of a stomach, or a sickening, sinking feeling, or even pain, which may be extremely severe, as happens in the gastric crises of some spinal cord diseases. Moreover, muscular manifestations of other structures are apt to occur, of which hiccough or deep sighing are among the most frequent. A simple exaggeration of the normal peristaltic movements results in propelling the contents of the stomach into the duodenum with undue haste, and the consequent causation of a feeling of emptiness or hunger sooner after a meal than is usual. If, as sometimes occurs, the peristalsis is in the reverse direction, the intestinal contents, even those of the colon, may find their way into the stomach and be thence ejected. A rare manifestation of this perversion leads to rumination or merycismus, when the food is chewed, swallowed, and then brought up exactly as in ruminant animals. This has been seen in persons the subject of grave nervous diseases, but has also been known to be acquired by imitation and practice. The motor disturbance may take the form of definite spasm, sometimes affecting the entire stomach, though this seldom causes any discomfort resembling intestinal cramp or colic. Spasm of the cardiac aperture is usually nervous, though may be induced by hot or irritating ingesta; but the pyloric spasm is most often caused by a hyperacidity of the contents, and is a frequent cause of severe epigastric pain two hours or more after a meal.

Deficient muscular power in the stomach is a common symptom of any state of bad health and general enfeeblement, of anæmia, chlorosis, and the like, as well as chronic catarrh of the organ; less often is it a manifestation of a purely nervous condition, though temporary inhibition of its exercise may accompany great emotion or anxiety. The resulting symptoms of this atony are those of delayed digestion, with a sensation of weight and distension with flatulence and eructations. Relaxation of the cardiac and pyloric orifices may occur, unduly facilitating the passage of gas in the ingesta in abnormal directions.

Treatment.—For the satisfactory dealing with that form of gastric indigestion that is essen-

tially nervous in its origin, and the treatment of the sensory, motor, and even the secretory disorders which in varying combination constitute "nervous dyspepsia," it is of primary importance to take into consideration the general condition of the individual, and not confine attention to the stomach and its misdoings. Indeed, it is very often absolutely necessary, in gaining the confidence of the patient, to appear to be disregarding the digestive troubles in endeavouring to disabuse his mind of his "liver being out of order," or of that much-abused organ being the seat of his trouble. Such patients are commonly full of notions as to the nature and cause of their malady, and are very apt to neglect all advice that does not fit in with their preconceived ideas, and consider their case is not properly understood unless something is done to "touch" their "sluggish liver." The widespread advertisements of pills and nostrums for the cure of all digestive troubles fosters their erroneous conceptions, and their self-dosing does much to make their illness more difficult to treat. Hence it is that not only in attending to the general condition of the patient must such conditions as chlorosis or other underlying perversions of nutrition receive careful treatment, but the habits and occupation, with the mental and emotional state of the individual, be investigated, as well as the existence of neurasthenia or other nervous disease, and, if need be, corrected. Quite as much good may be done in these directions by change of scene, a rest from work, and other such measures, as by remedies specially directed to the stomach itself.

As contributing to the general treatment, it is very desirable that the sufferers from nervous dyspepsia should be kept warm, and that their clothing should be suitable and sufficient for the limbs as well as for the trunk. Such patients are liable to suffer much from cold feet and hands and to specially "feel the cold," and such an indication must be met by application of warmth or by the prevention of loss of heat by their apparel. A woven or flannel abdominal belt is a very useful adjunct to the ordinary underclothes, and night-socks or hot-water bottles to the feet or belly afford much relief and materially assist the circulation. Hot fomentations or similar applications are of the greatest service in severe paroxysms of gastric pain, and should be employed whatever else may be done.

Whilst on general hygienic grounds it may be advisable to recommend moderate and regular exercise, it must be remembered that the subjects of the malady under consideration are very likely to be easily tired, and that fatigue generally favours neuropathic manifestations. Caution, therefore, is necessary as to the degree and character of the exercise to be taken, and anything like exhaustion must be avoided. Indeed, it is frequently well to order, if only as a preliminary or adjunct to other treatment, a partial or complete "rest cure." Resting before and after a meal should be carefully observed. Among the errors of living in such cases is a walk home, after a day's office or other work, before dinner. Early rising and cold bathing, whatever may be their merits for others, are not suitable for the nervous dyspeptic, who may often be recommended to breakfast in bed so as not to start the day tired. At the same time, restrictions must be put upon the engagements and entertainments later in the day, when such patients are often at their best and feel quite fit for considerable exertion, although at the cost of exhaustion and increased suffering next day.

All-important, of course, is the question of diet, but at the same time much judgment and discrimination are required in laying down rules for it, since it is most desirable that the patient should not be continually thinking of what he should eat or avoid, and should be prevented as far as possible from the habit of introspection upon his condition, whether this refer to his food or to the action of his bowels, both which subjects occupy a large share in the thoughts of many a neurotic man or woman, and, in the writer's experience, more frequently the former. Many is the dyspeptic who, if not self-made, is at least self-continued by the pursuance of some ridiculous dietetic regimen for which he offers some reason which is as ignorant as it is absurd. Excellent and essential as a regulated dietary is, both for getting well and for keeping well, the writer ventures to affirm that as many cases of indigestion exist whose cause is as clearly attributable to some course of diet the components of which may be physiologically without reproach, as there are those whose ailment is the direct abuse of dietary prudence; and the recent introduction of patent foods, extracts, and especially predigested aliments is largely responsible for this result. The idea that this, that, or the other plain, digestible, and nutritious article of food will disagree is with many a fad that has been encouraged, though it must be admitted that idiosyncrasies in respect to the digestibility of ordinary foods are occasionally to be met with, and must be allowed for. Hence in this class of case it is very common to furnish the patient with a written dietary to be followed. Except for special reasons, let the food be as varied as possible, with due regard to its digestibility; and it is a common experience that individuals who are, as the phrase is, "martyrs to indigestion" may partake freely of even a public dinner and feel better rather than worse for the transgression of their self-imposed rules.

In a large number of cases, no doubt, where careful examination and the patient's own account have shown the secretory, the motor, or the sen-

sory functions of the stomach to be really impaired, then a regulated diet must be insisted on. When a state of supersecretion or hyperchlorhydria exists, the more the food is confined to simply lean meat with a very small amount of rusk or dry biscuit and hot water, or very weak tea without sugar, between meals, the better. A milk diet for a few days will often suitably precede this plan. The digestion of other alimentary principles is clearly defective in such a condition, just as in the opposite state of hyperchlorhydria proteids should be avoided and a carbohydrate dietary adopted. It is well also in this condition to encourage the taking of salt, as this is the source of the deficient acid. In other neurotic disturbances it is well to aim at returning to ordinary meals at the usual times, and this course may be soon re-established even in patients who seem the most resistent. It need not be said that obviously indigestible articles—pastry, nuts, cheese, pickles, etc.—be eliminated from what is taken, at least at first.

Very considerable assistance to digestion may be given by the administration of hydrochloric acid, immediately before or after meals, in those conditions when this is shown to be deficient, and particularly when there is flatulence and eructations from faulty carbohydrate digestion, with cardialgia from the presence of an excess of organic acids. The uncertainty as to the variations in the amount of pepsin secreted, and its not corresponding with alterations in the hydrochloric acid produced, render the administration of this agent less certain, and rules for when it should be given are not easy to formulate unless analysis has clearly shown its deficiency. It certainly is not so generally useful as is the acid. The writer has found a very satisfactory way of giving pepsin is in the form of Benger's liquor pepticus, one or two teaspoonfuls before meals in a couple of ounces of Liebig's beef tea as ordinarily made and allowed to become tepid, not being taken hot. Ten or fifteen drops of dilute hydrochloric acid may also be added to this. The Liebig's extract furnishes the material from which the gastric glands in great measure elaborate their secretion. When there is hyperchlorhydria the giving of acid is clearly inadmissible, and alkalies, soda and potash salts, are indicated. Although giving relief to the symptoms, it is only of a temporary character; and, far from curing the underlying secretory fault, they really tend to intensify it. Preparations of atropin or belladonna, with the dietetic measures indicated, are of the most value for this condition.

For the pain and other sensory disturbances, as also for vomiting, sedatives are necessary, such as hydrocyanic acid, preparations of bismuth, oxalate of cerium, aqua chloroformi, codein, cocain, and morphia. Of these the first three named are most efficiently given in an effervescing mixture, and for milder degrees of discomfort may be sufficient. In the intense agony of some gastralgic attacks, morphia is a necessity, and even then may well be added to the bismuth and hydrocyanic acid. Hot drinks, especially containing a little brandy or peppermint, will sometimes act well, and when the pain is due to pyloric spasm from the irritation of excessive acidity, a full dose of sodium or potassium bicarbonate with a carminative is effective. If vomiting prevents anything being retained in the stomach, a hypodermic injection of morphia or a rectal injection of chloral (gr. xv.) and potassium bromide (gr. xl.) may be given. The need for caution in the administration of morphia is obvious, but it must not be forgotten that when pain is constantly recurring, especially in neurotic subjects, it tends in a great measure to become a "habit" which may be broken quickest by a few daily repeated effective doses of an opiate, concealing if possible from the patient the nature of the remedy given. Topical applications of heat, fomentations, hot bottles, sinapisms, or turpentine stupes are of the greatest service. Supplementary to the local anodynes are those which produce their effect rather as general sedatives—phenacetin, antipyrin, chloral, cannabis indica, hyoscyamin, etc.—and may be advantageously employed.

Another group of remedies—antiseptics—for the correction of organic fermentations are not on the whole as effective as might be supposed within the dosage limits of the drug that is permissible. The most commonly employed are creasote, carbolic acid, resorcin, and salicylic acid, the last-named being probably the best. They may be rendered more efficacious if given with essential oils, as of peppermint, rosemary, cajuput, etc., made into a draught with aq. chloroformi, itself an antiseptic. Charcoal in cachet or biscuits is convenient when a prolonged administration is requisite. Assafœtida in emulsion acts well, and often succeeds when other drugs have failed. For flatulence and gaseous eructations these same agents are used, being given between meals, a draught containing hydrochloric acid and a vegetable bitter preceding the food. General tonics, as quinine, iron, or arsenic, may be called for in improving the general tone in conjunction with such hygienic measures as have been referred to.

If the reluctance of the patient can be overcome, lavage is usually beneficial, except perhaps when the gastric digestion is unduly hurried; in all cases of delay in the process it is called for in proportion to the urgency of the symptoms. When impracticable, an emetic, and the encouragement of vomiting by full quantities of warm water may go some way to replace it. The disagreeables connected with the passage of a stomach tube are soon overcome if the patient will really try, and it is seldom that it is really impossible if the individual is willing

to persevere for a few times, when he will then probably pass it himself without any discomfort. To a bystander the performance appears to be much more distressing than it really is. By washing out the stomach, not only may the noxious products of defective digestion be removed, but the opportunity is offered of the direct application of remedies to the surface in the form of sprays, as of carbolic acid, menthol, nitrate of silver, etc. In practical hands the method of intragastric faradisation, or galvanism, the positive pole being introduced into the stomach and the negative placed on the spine, has been found of great value in the treatment of most of these neuroses of the stomach, and this is much facilitated if the patient has been accustomed to the passage of a stomach tube.

Special Symptomatology and Treatment of Inflammation of the Stomach and Duodenum.

Acute Gastritis

Symptoms.—Having regard to the wide range of causes, from an indiscretion in diet to a single dose of an irritant posion, or the invasion of pyogenic micro-organisms, it is to be expected that a considerable variation in the intensity of symptoms is exhibited by the cases comprised under this term.

In the milder cases, when the condition supervenes upon previous good health and the cause is a temporary one, the patient may complain of but a slight feeling of malaise with disinclination for exertion, and an elevation of temperature by a degree or degree and a half, or perhaps not even so much. The symptoms otherwise are chiefly referable to the stomach, as loss of appetite, and usually thirst; a sense of discomfort even amounting to pain in the epigastric or left hypochondriac regions; a feeling of nausea, and probably retching or vomiting at first of such food as may be in the stomach, but little digested, and later of a little mucus and sour fluid, examination of which shows an absence of hydrochloric and the presence of organic acids—lactic, acetic, or butyric. The tongue is coated and foul, and the breath offensive. The bowels may be unaffected, or there may be some diarrhœa. Of symptoms remote from the digestive organs, a slight degree of headache, frontal or occipital, and a somewhat quickened pulse are the most usual.

According to the character and intensity of the exciting cause, any or all of these symptoms may be much increased in degree. The slight sense of illness may deepen into a state of prostration, and such is specially likely to be the case in children, in whom also the intestine is somewhat more prone to be simultaneously affected. The temperature may reach 103° or even higher, this being in some measure determined by the temperament of the patient. The pain may be severe, of a burning character, and shooting through to the back, increased by deep breathing or by anything but the blandest material swallowed. Tenderness also may be elicited over the epigastrium, and the abdominal muscles are rigid or contract on the slightest pressure.

When the gastritis is the result of a corrosive poison, pain is severe, and is felt in the throat and gullet as well; the retching and vomiting is most distressing, and the material brought up is frequently blood-stained with shreds of the mucous membrane; the motions may also contain altered blood, and defecation may be painful. The general symptoms are much intensified, the patient becomes cold and collapsed, with a small, scarcely perceptible pulse and rapid shallow breathing, increasing until death occurs from cardiac failure, sometimes with convulsions or coma; or there may be peritonitis, to which the fatal result is attributable.

In *phlegmonous* or *suppurative gastritis* the symptoms are also severe, especially those indicative of the general condition, but none are peculiar to the disease. There is a state of grave illness which rapidly deepens, and death commonly ensues in the course of a few days, though occasionally it has been known to continue for weeks. The temperature ranges higher as a rule than in other forms of gastritis, and may reach and remain at 104° Fahr. or even higher; the nervous symptoms, such as pain, restlessness, delirium, and coma, are considerable; jaundice may develop, and vomiting, constipation, or diarrhœa, a dry brown tongue, thirst, and loss of appetite are constant. When the suppuration is circumscribed and an abscess is found in the gastric walls, pus may appear in the vomit from a bursting of the same, but short of the occurrence of this phenomenon, the diagnosis will remain uncertain, though the nature of the case may be suspected.

The symptoms of *chronic gastritis* are essentially those of a chronic gastric dyspepsia, since that is the usual morbid state underlying the clinical complex known as chronic gastric indigestion, when that malady is not purely nervous in origin. It may become established as a sequence of acute gastritis, or may slowly develop without any definite commencement as the result of obstructed portal circulation, of continued infection from oral sepsis, or in the course of chronic toxæmias, such as gout, chronic nephritis, etc., but its most frequent cause is probably to be found in the continued mal-digestion of food in the stomach, whether from imperfect secretion of gastric juice, impaired motility of the organ, or oftenest of all from the repeated subjection of the mucosa to improper ingesta. Hence, besides occurring alone, it is an almost constant accompaniment

of a dilated stomach, and commonly is found with other gastric diseases, such as ulcer and cancer. The general result of the structural changes which characterise a chronic catarrh of the gastric mucosa is to impair the movements of the organ, to lead to a secretion of juice which is deficient in quantity or in hydrochloric acid, and probably to set up an undue sensitiveness of the membrane; the organ hence becomes deteriorated in turn, and is liable to dilate. Once established, therefore, chronic gastritis tends to produce or to intensify those conditions to which its occurrence may have been due. As might be supposed from the varied circumstances attending its causation, the symptoms it gives rise to are varied in range and character, from the mildest degree of discomfort to almost continuous suffering. Broadly speaking, the condition is one of delayed digestion, marked by a sensation of weight or oppression, or even slight pain, that comes on some time after food, and may continue for several hours. There may be some tenderness, especially on pressure over the stomach, and exertion even of deep breathing may cause discomfort in that region. The appetite is indifferent or variable and capricious. Flatulence with consequent eructations of gas, that are frequently induced with difficulty, though affording considerable relief when they have occurred, are among the most constant indications. There is a general liability to nausea, especially in the morning, and vomiting also is apt to be most frequent then, due, as it often is, to the absorption of poisonous products of digestion. Indeed, auto-intoxication is most probably the explanation of many of the remote symptoms of this condition, such as the dull, heavy headache so constantly met with, the lassitude and disinclination for mental and bodily exertion, muscular cramps and vertigo. The vomit or material artificially withdrawn from the stomach shows a deficiency of hydrochloric acid and excess of mucus; the results of proteid digestion may be recognised, and the products of carbohydrate fermentation. The appearances of the tongue are less indicative of the state of the stomach and digestion therein than was formerly supposed; it may be thickly coated, or large, flabby, and indented with the teeth and clean, or red and denuded; such variations are more dependent on the state of the mouth, teeth, and mode of breathing, and all may be met with in the course of a chronic gastric catarrh. A nasty taste in the mouth and foul breath are usually complained of. The ill effects of the indigestion on the general nutrition are seen in the wasting, the muddy complexion, the anæmia, and the condition of the urine, which is frequently scanty, high-coloured, and concentrated, throwing down lithates, or uric acid, or oxalate of lime crystals. The digestive processes in the intestine are more or less upset by the ill-prepared food in the stomach; and constipation, with attacks of diarrhœa, flatulence, and other symptoms, complicates the initial gastric disorder. All degrees and combinations of the conditions enumerated characterise the various cases of this very common complaint.

In patients suffering from this disease the examination of the stomach-contents and the digestive process by Ewald's test-breakfast is often of very valuable assistance (see article "Digestion and Metabolism," vol. ii. p. 370). In making the diagnosis, attention should be paid to the possible existence of other stomach affections, or of general diseases, such as gout, etc., and still more to the habits and diet of the patient. Upon the nature of these several circumstances and the steady pursuance of treatment the prognosis of the case will mainly rest.

Inflammation of the duodenum, apart from a similar condition of the stomach or of the intestines, is of doubtful occurrence clinically, and gives rise to no symptoms by which it can be certainly diagnosed. Simple catarrhal jaundice is commonly attributed to a mild duodenitis, but there is no reason to regard the duodenum as the sole part of the canal affected, and the supposed occurrence of inflammation in this situation as the result of toxic excretion in the bile has been referred to in considering the morbid anatomy of these organs.

Treatment.—The ordinary cure of acute or subacute gastric catarrh requires no treatment, as a rule, beyond entire abstinence from food for twelve or twenty-four hours, washing out the stomach by drinking warm water freely, and a mild mercurial purge. If there be much pain, an effervescing mixture containing liquor bismuthi et ammoniæ citratis, with hydrocyanic acid, will be required; and if it be clear that the stomach is empty, and yet retching and vomiting be excessive, a quarter of a grain of cocaine with one drop of carbolic acid in a mucilaginous draught will be found very useful. A hot bottle or fomentations to the abdomen will give great comfort.

In the more serious forms of gastritis following irritant poisons, appropriate antidotes will be required, and probably opium for the relief of pain. The general state of the patient demands attention, and stimulants or strychnine to avert fatal collapse. Except in this same direction, little can be done for the very serious phlegmonous form of inflammation.

To ascertain and if possible remove the cause is the first and most important step in the treatment of a chronic gastritis. When this is due to errors in diet, whether of quality or quantity, alcoholic excess, insufficient mastication, or the state of the teeth and gums, correction of the fault may of itself be soon attended with cure. So satisfactory a result

cannot be looked for when the catarrh is the consequence of a chronic congestion from portal obstruction, or is the accompaniment of dilatation or cancer of the stomach, and palliative measures alone are possible.

The indications for treatment are threefold—to do what is possible to restore the damaged mucosa, to make up for the deficiencies in the digestive process, and to treat the symptoms to which these conditions give rise. Working as they do in a vicious circle, relief at any point contributes to the general improvement. If complete rest could be given to the stomach, the chance of its self-restoration to a normal state would doubtless be much advanced, but this is of course impossible, as the patient must be fed, and in such cases the demand for nourishment is often especially great. General tonics, change of air, and treatment at chalybeate or other spas, *e.g.* Harrogate, Homburg, Ems, Vichy, etc., where the dietetic requirements are enforced, are called for in severe and long-standing cases. Bismuth and nitrate of silver are the drugs that probably exert the most directly beneficial effect on the mucosa, and it is said that their efficacy is increased by their intra-gastric application in the form of spray. Karlsbad salts are a beneficial adjunct to any treatment that is adopted. Digestive deficiencies may be in great measure remedied by regulation of the diet, etc., since in chronic catarrh the active agents of the gastric juice are commonly diminished in quantity, and by the administration of hydrochloric acid and pepsin with vegetable bitters.

The general principles that should be observed in this respect (and further detail is impossible in the space available) have already been set out in the preceding section, and the same may be said as regards the lines of treatment for the individual symptoms of the resulting dyspepsia, which are in the main alike, whether the underlying cause be a structural change (chronic catarrh) in the mucosa, or a perverted nervous control of the motor secretory and sensory functions of the stomach.

Special Symptomatology and Treatment of Ulcer of the Stomach

The symptoms of a typical case of gastric ulcer are few in number and precise in character, presenting a clinical picture concerning the nature of which there can be little mistake. But in the consideration of all cases which may fairly and properly be comprised within this category, very considerable exceptions have to be made, and no one of the symptoms, even of those most definite, is of invariable occurrence. Severe epigastric pain, much intensified, or called forth by food and unrelieved until the stomach be emptied of its contents by vomiting or by propulsion through the pylorus, with a more or less profuse hæmatemesis, occurring in a young person, especially a female, constitute the leading features upon which a diagnosis would be made without much hesitation. There exist, however, great differences in the general condition of the individuals in whom such symptoms may occur, in the subsequent course and complications which may arise, and, so far as is known, in the character of the gastric lesion; so much so, that whilst closely corresponding in the essential manifestations, patients suffering from what is with good reason recognised as ulcer of the stomach nevertheless are widely contrasted in the entire clinical characters of their disease. Hence it will be convenient first to refer *seriatim* to the several symptoms in detail, and subsequently to describe the general course of the main types of the malady.

Pain.—Of the three leading symptoms—pain, vomiting, and hæmatemesis—pain is the most constant, and in cases of extremely rapid course which terminate by perforation it may be the only symptom, to be followed at once by collapse and other evidences of peritoneal involvement. Sometimes the pain is almost or quite continuous, and sufficiently intense to interfere with sleep, but far more often there are periods of relief, a paroxysm being excited by the food that is swallowed, setting in within a few minutes to half an hour or more afterwards. Some attempts have been made to locate the situation of the lesion by the time that elapses between the taking of food and the onset of pain, the longer the period the nearer to the pylorus; but since the pain is often partly of neuralgic nature, being induced by other conditions, such as exposure to cold, excitement, exertion, or even by menstruation, the result is not altogether satisfactory. The character of the pain is variously described as burning, boring and shooting through to the back, sometimes so severe as to cause fainting, and tending to become more intense as the case progresses. As a rule, it is strictly localised, and the patient points to a spot just below the ensiform cartilage, sometimes as well, or it may be only, at a spot in the back immediately to the left of the tenth or eleventh dorsal vertebra. Occasionally the pain radiates from the epigastric region, or, like so many pains of gastro-intestinal origin, may be felt about the umbilicus, or be referred to a higher point along the spine between the sixth and eighth dorsal vertebræ, or even to either shoulder or arm, or along the intercostal spaces. How far these variable situations are connected with the actual site of the ulcer is uncertain, although some indication of this may sometimes be obtained by noting variations in the degree of pain that follows alterations in the position of the patient; thus when relief succeeds to lying on the face, the ulcer may be on the posterior wall, or at the cardiac end when the right decubitus is assumed. Pressure over the epigastrium almost always increases the

pain, and the tenderness and hyperæsthesia in this region may be so great that even contact with the bed-clothes is unbearable.

Such are the usual characters, but to each one of the statements exceptions occur. Thus, pain may be wholly wanting. Large ulcers have been found in the stomach post-mortem, which have given rise to no symptoms during life, and whose existence was quite unsuspected; or it may be that a violent hæmatemesis has first suggested the lesion, and a painless recovery has ensued; or pain may cease for long periods, to recur later, whilst other evidences of ulcer persist. Or, again, the pain may have no such definite relation to food as here described; it may come on when the stomach is empty long after a meal, or it may be almost continuous, and but little, if at all, influenced by what is swallowed. The explanation of this is doubtful; a flow of gastric juice of increased acidity has been suggested to account for the former phenomenon, and this may be why food has very rarely been known to relieve the discomfort; and the permanently distended stomach may determine a constant pain, although the associated gastritis may be partly responsible. Very exceptionally, pressure over the epigastrium has been known to afford relief, and in a case of duodenal ulcer within the writer's knowledge which was fatal by perforation, this circumstance was very marked.

Vomiting.—This is almost if not quite as constant a symptom as pain, being very seldom absent when the ulcer is in the usual situation, viz. on the posterior wall at the pyloric end, although when the lesion is on the anterior surface or at the fundus it may not occur. Like the pain, it is usually induced by food or by an accumulation of saliva that has been swallowed, which act as irritants to the exposed nerves; at the same time it is also liable to be excited by mental or bodily exertion, or other circumstances acting reflexly. As a general rule the pain is relieved, perhaps entirely, by the vomiting, although exceptions to this do occur. Hydrochloric acid is always present in the vomit, very often in excess, together with the products of digestion, albumose, etc., and frequently lactic acid. It is, however, the presence of blood, usually in large quantity, from several ounces up to one or even two pints, that especially characterises the ejecta. The hæmatemesis may occur only once or be repeated twice or more within a day or two, and is not infrequently preceded by an accession of pain, or by peculiar sensations of heaviness or distension of the stomach. The blood is bright, and coagulates after being voided, or clots may be brought up. However profuse the hæmorrhage may be, it is comparatively seldom fatal, though such a result is not unknown, and death has followed an escape of blood into the stomach without any being vomited or passed per anum. The bleeding, of course, reduces the patient to an extreme degree of faintness, and this, as well as pallor, is proportionate to the loss of blood. In exceptional cases hæmatemesis is the first symptom to suggest the presence of an ulcer in a patient who has made no previous complaint of either pain or vomiting, or even of the mildest dyspeptic troubles. Such blood as passes on into the bowels is ultimately voided as a black material resembling tar, due to the decomposition of the blood by the gastric juice, and the conversion of the iron of the hæmoglobin into the black sulphide by the sulphuretted hydrogen in the lower intestines. This constitutes true "melæna," a term that is often improperly applied to any hæmorrhage from the bowel, whether this be of bright or reddish-brown altered blood. When the ejecta are actually black, it is proof that the source of the blood is above the entrance of the bile-duct, and that it has been submitted to the action of the gastric juice.

Investigations directed to the functional capacity of the stomach when the seat of an ulcer have demonstrated a very constant excess in the secretion of hydrochloric acid, which has previously been referred to, properly playing some part in the production of the lesion. This hyperchlorhydria may even be met with when the stomach is empty, and in the dilatation which may follow on pyloric stenosis caused by cicatrisation of the ulcer. The pepsin also would appear to be frequently increased. Some deficiency of gastric motility is apt to occur when the general health is much impaired, as in chlorosis or in gastroectasis; and such absorption as takes place from the stomach is alleged to be delayed in this disease.

Associated with these very definite manifestations, there is a variable degree of gastric dyspepsia, which may be due to a chronic gastritis of some duration, in connection with which the ulcer may have been developed; or the indigestion may have been of the nervous variety and closely connected with secretory or motori-sensory disturbances in the stomach. Since, also, the greater proportion of cases classed as gastric ulcer occur in young and chlorotic women, the failures in normal gastric digestion as well as many of the general symptoms may be properly referred to the quality of the blood and the malnutrition dependent thereon. Thus it is that the appetite is commonly very indifferent or capricious, and thirst is complained of, especially if there have been any hæmorrhage; the tongue is pale and flabby and indented by the teeth; and constipation, due to the deteriorated tone of the intestinal musculature and the lack of adequate stimulus to peristalsis from the small bulk of the contents, is the rule. With these are various degrees of discomfort, perhaps amounting to pain in the stomach or abdomen generally, with a sense of

fulness and sinking. But such symptoms as these by no means necessarily occur, and they are not peculiar to nor even essential manifestations of ulceration. They may have existed for long previous to those due to the ulcer, or they may set in when those caused by the specific lesion have in great measure passed away, or they may be wholly absent throughout.

Other evidences of perverted function which may be met with it the course of gastric ulcer are probably only remotely related to that condition, and are rather the secondary expressions of disturbance, or result from the general state of bad health accompanying the special stomach affection. The temperature, apart from any inflammatory complication, is normal or even below. The heart, which is generally undisturbed, may become irregular and develop various murmurs when the anæmia is considerable; from lack of sufficient nourishment the force and tone of the circulation is likely to be depressed. To the general state of ill-health and dyspepsia may also be ascribed such specially nervous phenomena as headache, vertigo, and sleeplessness. Dr. Dreschfeld records three cases in which general convulsions occurred, probably in connection with hæmorrhage, and the same observer also saw tetany in one case, occurring independently of washing out the stomach. The subjects of the malady being most frequently young women, the symptoms of neurasthenia or of hysteria are not unlikely to coexist. The urine may show some abnormalities due to the altered gastric state; the hypersecretion of hydrochloric acid may considerably reduce the acidity of the renal excretion, in which also the chlorides may be diminished and the phosphates increased. Both albuminuria and albumosuria may occur, and glycosuria is not unknown; indican and ethereal sulphates bear witness when in excess to unhealthy bacterial fermentations in the intestines. Amenorrhœa is a very constant occurrence in the chlorotic young women.

Course and Termination.—Within the limits of the foregoing account almost every case of gastric ulcer would find a place; it is in proceeding to consider the course and termination of the disease that marked differences of type are disclosed.

(*a*) *Recovery.*—By far the greater number of cases of what is a far from uncommon affection get well, and this is pre-eminently so when the subjects are chlorotic young women, who form the greater proportion. Coming on in a patient profoundly anæmic, and with a vitality and capability much impaired therefrom, or supervening suddenly in a girl who is only just able to drag through her day's work, she is in a very short time reduced to an alarming state of prostration from loss of blood, which, as said, may recur on two or three days. Yet with care recovery almost always follows, though the patient is left more anæmic than before, but with no specially marked gastric symptoms either of pain or vomiting. In a few months or a year these indications set in again, and another hæmorrhage takes place, again to be followed by recovery, and this may be again repeated, or the first outburst may be the only one. It is important to notice that a very large number of young women, especially of the servant class, are admitted to hospital suffering from repeated attacks of great pain and vomiting and all the recognised symptoms of gastric ulcer, except that there is no hæmorrhage; and it is customary to include at least the severest of them as gastric ulcer, thus helping to swell the preponderance of the disease in females. Some observers, however, hesitate to diagnose ulcer unless there be a loss of blood, and have been satisfied to designate such cases as gastrodynia. The special feature here insisted on is that the greater number, whether there be bleeding or not, recover, and many ultimately become perfectly healthy women as the chlorosis disappears. The recently introduced practice of treating gastric hæmorrhage by opening the stomach and ligaturing the bleeding vessel has given the opportunity for the exploration of the viscus after hæmatemesis; and in a certain number of such cases no ulcer has been found, and nothing more than a minute erosion of the mucosa. This fact has shown that a definite ulcer such as previously described is by no means necessary for the production of the intense pain, vomiting, and hæmorrhage, and it also suggests that it is not the actual lesion itself, but rather perhaps some general sensitiveness of the gastric mucosa, which may or may not be associated with bleeding according as the erosions happen to involve a vessel of any size, that accounts for the pain and vomiting. This would bring the bleeding and non-bleeding cases, as they occur in chlorotic girls, be it understood, within the same category, the hæmorrhage being, so to say, an accidental complication.

(*b*) *Perforation.*—Whilst the greater number of cases run an uncomplicated course towards ultimate recovery, a certain proportion terminate in this serious and usually fatal event. No indications exist that foreshadow such a result, and the clinical course of the case up to the occurrence of perforation may be in nowise different from those which recover. Post-mortem, however, as might be expected, a very definite ulcer extending through the several coats is discovered, presenting all the anatomical characters previously described. Inasmuch, however, as the "peptic" or "perforating" ulcer, there is reason to suppose, starts from a simple erosin, the difference in the clinical as in the anatomical characters of these cases is only one of degree. As with hæmorrhage, so with perforation, it may be the first symptom that calls attention

to the condition, and from a state of apparently sound health the individual rapidly passes into one of extreme danger. Such cases as these, in which these grave symptoms suddenly appear without previous discomfort sufficient to warrant complaint, have been termed "latent," a designation, it may be observed, which is still more applicable to those ulcers found after death, whose presence has been quite unsuspected during life, and have given rise to no recognisable symptoms whatever.

The actual proportion of cases of ulcer of the stomach which end in perforation is hard to determine, owing to the doubt as to what is exactly included under this name; probably it does not exceed 10 or 12 per cent. A curious difference has been noticed as regards the age at which this complication occurs in the two sexes, the average in women being between twenty-five and thirty, and in men between forty and forty-five.

The symptoms indicative of this accident are indistinguishable from those attending perforation into the peritoneum of the hollow viscera generally. There is commonly an attack of acute and agonising pain, not necessarily felt at the epigastrium, quite as often at the umbilicus or even diffused over the abdomen, the patient rapidly falls into a state of collapse, the temperature falls, the surface and extremities are cold and bathed in a clammy sweat, the heart's action is greatly reduced in force, and the radial pulse may not be felt, or is quick, small, and thready, the breathing is shallow and hurried, and consciousness remains. Unless death take place, peritonitis begins to be manifested within twenty-four hours, and to this the fatal end may be due, unless operative interference should have been successful.

When perforations have occurred on the posterior surface of the organ, and more particularly if there have been any adhesions previously set up by the extending ulcer, death is avoided, and an abscess of a short but more commonly of some considerable duration is formed in the post-peritoneal connective tissue —sub-phrenic abscess—though this is said to more usually follow a duodenal than a gastric lesion.

(*c*) *Cicatrisation.*—The healing of a gastric ulcer is known rather by post-mortem observation than by any special manifestations during life, and this is particularly so since, though the lesion be healed, many of the symptoms are by no means necessarily removed. Pain after food may continue, whether from the scar being irritable or from the interference to the peristalsis offered by the interposition in the muscular coat of a band of fibrous tissue, or it may be from adhesions which have been developed externally to adjacent parts. The vomiting may also continue, and this with the pain may maintain the general ill-health of the patient. Very many cases, however, do recover completely, and in such it is allowable to assume a satisfactory cicatrix has been formed.

The subsequent contraction of the scar is very liable to set up a fresh set of difficulties. If it have been in the neighbourhood of the pylorus, stenosis of the orifice, even to an extreme degree, may ensue, and lead to very considerable dilatation; or should the ulcer have been situated on the lesser curvature and extend over both surfaces of the stomach, an "hour-glass contraction" is very likely to be the result.

(*d*) *Chronic Progressive Ulceration.* — Some cases which have at the outset conformed to the general character and course of gastric ulcer, instead of recovering or of ending in perforation or cicatrisation, continue to exhibit symptoms more or less continuously, or perhaps only at intervals over many years. Here again it is in great measure what is found post-mortem that enables us to assign the case to its proper group. There is found after death an ulcer perhaps of considerable size—several inches in diameter—that has completely extended through the walls of the stomach, the base being formed by the pancreas, liver, or other adjacent structures. At the same time, it must be admitted that such a lesion has been met with that has given rise to little or no symptoms during life, and has run an entirely "latent" course. It would seem very probable that such a condition is due to firm adhesions having been developed in the progress of the ulceration, thus averting what would otherwise have been a perforation into the peritoneal cavity, and that these same adhesions have at the same time prevented cicatrisation, with the result that the ulcer has slowly extended, finally to terminate by perforation or by erosion of a large vessel and fatal hæmorrhage. When this state of things has existed in the pyloric region, the chronic inflammatory process, giving rise to a considerable formation of fibrous tissue, comes to form a tumour which may require very careful consideration to distinguish from a malignant growth.

Diagnosis.—The recognition of the existence of ulcer of the stomach is under usual conditions easy. Special attention should be directed to the definitely localised character of the pain and tenderness, the relation of the pain to the taking of food and its relief by vomiting, to the occurrence of hæmatemesis, the presence in the vomit of an excess of hydrochloric acid, together with the age and sex of the individual, bearing in mind that exceptions to the general rule may be met with in respect to each of these conditions. According to the view taken as to how far simple erosions which, it has been demonstrated, may give rise to all the cardinal symptoms of ulcer, are to be included within the term ulcer, so will be the diagnosis of many

milder cases in which perhaps the hæmorrhage is quite absent. To some of these cases the name gastralgia is possibly more applicable, especially since some of the pain and vomiting even with definite ulcer are probably due to a hyperæsthetic state of the gastric mucosa. If the pain be relieved by food the condition is most likely to be one of hyperchlorhydria. Much reliance may be placed on the strictly localised character of the pain and tenderness, for though this is not invariable it scarcely if ever characterises the pain of other gastric affections or of lesions of neighbouring parts. It is specially serviceable in helping to distinguish ulcer from cancer of the stomach, together with due consideration for the age of the patient, the excess of hydrochloric acid in the stomach contents in ulcer, and that the blood brought up is oftener "coffee-ground" than bright in character in cancer, and is seen late in the disease and not at the outset. But these features are less distinctive when the ulcer is one of long duration in a person over middle life, and the diagnosis becomes exceedingly difficult when an epigastric tumour is to be felt, such as a dense inflammatory thickening might give rise to. This is the more important as much benefit may result from operation in the one case, and harm rather than good in the other. It is needful to consider the whole bearings of any particular case, especially its duration, the mode of onset, the development of a cachexia or otherwise, as well as the special points of difference to which attention has been directed.

The differentiation of gastric from duodenal ulcer will be more conveniently referred to under the description of the latter condition.

Prognosis.—The uncertainty of the course and termination in any case presenting the symptoms of gastric ulcer will be apparent from the foregoing account. The greater number recover completely, although there may be recurrence before good health is fully established; very many exhibit symptoms more or less severe for many years, and finally succumb to one or other of the complications which may be associated with the ulcer or even follow on its healing; and lastly, a minority die within a short time, days or weeks, from the recognised onset of the disease. Statistics of these several groups are very various, and afford but little help in forecasting the probable course of any particular case. It has been estimated that 5 per cent of the entire population suffer from ulcer of the stomach, and that in 80 per cent of these hæmorrhage occurs, about 7 per cent of which are fatal, and in nearly 3 per cent death is due to perforation. But too much importance must not be attached to these figures. Of the proportion of recovered cases, and of those which remain chronic invalids, statistics are wanting. The most definite assertion that can be made is that the severest case of hæmorrhage may recover, and the apparently mildest case may be rapidly fatal from perforation, though surgery is doing much to reduce the risks of both these accidents. The deteriorated health induced by the malady may favour the invasion of tuberculosis.

Duodenal Ulcer

Although of commoner occurrence than is usually supposed, this affection is less frequent than ulcer of the stomach, which it closely resembles in its clinical features, as it also corresponds in anatomical characters and pathogeny. Mention has been made of the singular difference in respect to age and sex incidence; and the disease is far less frequently associated with chlorosis than the stomach affection.

Symptoms.—As with gastric ulcer, not a few cases exhibit no symptoms until the occurrence of a fatal hæmorrhage, or more often perforation, which is followed by death within twenty-four or forty-eight hours; and the frequency of these "latent" cases is further demonstrated by the not uncommon occurrence of cicatrices in the duodenum found post-mortem, with no history of any symptoms pointing to the existence of an ulcer during life. Sometimes, no doubt, such cases have exhibited vague and indefinite dyspeptic trouble, pain, discomfort, a sense of fulness, impaired appetite, etc., which have been attributed to a mild, subacute, or chronic gastritis (dyspepsia), and have been paid but little attention to, and in the absence of more definite indications it could not well have been otherwise.

When, however, symptoms are well marked they follow, as said, those manifested by a gastric ulcer, with such differences as serve as grounds, often far from certain, for a differential diagnosis.

Pain which exhibits all varieties of character and severity, from a very moderate dull ache to being severe and agonising, is less constant in its occurrence than when the stomach is affected, and as a rule is experienced one to three hours after food is taken. It is seldom very definitely localised in situation, and is felt more generally over the right hypochondrium rather than in the epigastrium, extending into the right loin, and is certainly less often referred to the back, though it may be felt in the right shoulder. Pressure over the painful region may increase the discomfort or the reverse. Vomiting is much less frequent than in gastric ulcer, nor does it afford any special relief to the pain, and like that symptom occurs several hours after food. It may be altogether absent, or only occur once or twice in the course of the malady, hence its diagnostic value is of much less importance. The vomit may contain traces of altered blood, possibly also of bile, and there is said to be no such constant excess of hydrochloric acid as is met with in the stomach affection.

Hæmatemesis also occurs much less often, and only when a very considerable hæmorrhage takes place. Melæna, on the contrary, is more frequent, and takes the place, as it were, of hæmatemesis, which it often precedes over some period.

The general malnutrition which such a disturbance of the digestive process engenders is shown by the wasting and muscular weakness, as also by the state of the blood, which in this as in gastric ulcer comes to resemble that characteristic of pernicious anæmia, and is still more marked in cancer of the stomach, a circumstance which lends support to the view that the essential cause of this great blood disease is some autogenetic toxin developed in the gastro-intestinal tract. The bowels are apt to be confined, or this state may alternate with diarrhœa. An associated catarrh of the duodenum may determine a moderate jaundice.

Prognosis.—Deaths may be due to hæmorrhage, but oftener to perforation, and occasionally from progressive malnutrition. A fair number of cases, in whom there is reason to suspect the existence of this malady, may go on for some years, with exacerbations at intervals, which may be of long duration, and it is not unusual to meet with patients who give an account of what strongly suggests duodenal ulcer many years previously, during which there has been almost complete relief with subsequent recurrence. Cicatrisation of the ulcer may lead to stenosis of the bowel, with all the troubles dependent thereon; or the orifices of the bile and pancreatic ducts may be involved in the scar, with the production of persistent and severe jaundice, and great emaciation, with fatty stools, etc.; or perforation instead of being immediately fatal, as it most usually is, may give rise to a subphrenic abscess or establish a fistulous communication with the colon or gall-bladder. As in the stomach, the scar has been known to be the seat of subsequent cancer.

Diagnosis.—The data for distinguishing between a gastric and a duodenal ulcer have been sufficiently set forth in the account of the symptoms which the latter exhibits, bearing in mind the age and sex differences of their occurrence in age, as well as the greater frequency of a pre-existing chlorosis in the stomach lesion, and of an extensive skin burn in the duodenal. But the diagnosis is not so easy as might appear from a description that aims at giving a generally complete account of these diseases rather than contrasting individual cases, and when the duodenal ulcer is close to the pylorus distinction may be impossible. An absence of symptoms of gastric dyspepsia is said to be noteworthy in duodenal ulceration, but this is not to be distinguished with anything like certainty, since the bowel lesion does in varying degree interfere with the stomach functions.

With somewhat more reason than gastric ulcer the symptoms of the duodenal lesion might be mistaken for gall-stone colic. The pain is felt much in the same situation, and may be referred to the right shoulder, though in the latter affection it is more paroxysmal, and there is more likelihood of vomiting, and jaundice is only occasional. A rise of temperature and perhaps a rigor and sweating are in favour of gall-stones.

Acute pancreatitis is a rare condition, which may resemble duodenal ulcer in some of its symptoms, and lead colic may be mistaken for it.

Treatment.—This should aim at healing the ulcer, and at the same time relieving the symptoms to which it gives rise or that are connected with such conditions as may be present, viz. chronic catarrh of the stomach, hyperchlorhydria, and chlorosis. To a great extent these several indications are met by similar lines of procedure.

When once the lesion has been diagnosed, whether subsequent to a hæmatemesis or not, and even when only reasonable probability exists for its occurrence, complete rest in bed should be insisted on, and should be maintained until well after all symptoms have ceased. By this means the risks attendant upon the malady are diminished, and the chances of complete healing and avoidance of a chronic intractable ulcer being established are increased.

Opinions differ as to the value of remedies that may be supposed to promote the healing by their direct effect upon the wound, such as nitrate of silver or subcarbonate of bismuth. By some, one or other of these substances is given regularly over some weeks, whilst others discard them as useless for the purpose assigned. The writer thinks benefit in this direction does follow a pill consisting of argenti nitratis gr. $\frac{1}{4}$ to $\frac{1}{2}$, sodii carbonatis exsic. gr. iij., kaolin *q.s.*, given two or three times daily.

The principle of rest should be still further applied by complete abstinence from food of all kinds, and feeding by nutritive enemata or suppositories. This is strictly to be followed if hæmorrhage has occurred. Thirst should be relieved by a teaspoonful of tepid water now and then and warm water enemata. It is very doubtful whether sucking lumps of ice, so often recommended, does not really favour the bleeding; and the stomach is apt to be burdened by a larger quantity of fluid in this way than is generally supposed. For how long rectal feeding should be continued depends on the ability of the patient to retain the injections and on the general condition, and also on the view of the case taken by the physician. Regularly washing out the rectum previous to the nutritive enema, and the addition thereto of a small quantity of opium, will allay the irritability of the bowel and permit a longer continuance of the treatment, which may in favourable cases be pursued for several weeks, though the patient

loses weight very considerably, and this fact should enter into the considerations limiting its duration. But there is another aspect of rectal feeding which is of considerable importance, especially since it is a method of alimentation that should not be entered on, or at least maintained beyond a few days, except from necessity. Observation has shown that very many cases of chlorotic girls exhibiting all the symptoms of gastric ulcer, and many others in whom hæmorrhage is alone wanting, do very well on a fairly good diet of solid food, including meat, almost from the first manifestation of symptoms, and much sooner regain their health than those who are kept on nutritive enemata and suppositories for weeks. It has also been proved at operation that some of them are the subjects of a minute ulcer or erosion, and it is probable that a very large number are suffering from a similar lesion. For such patients a full diet might reasonably be supposed to be innocuous, whilst the presence of a large ulcer that has penetrated through the mucosa to the muscular layer or even deeper might on equally good grounds be regarded as distinctly prohibitive. With the identity of symptoms in the two groups of cases the difficulty is to decide to which any individual one can be referred; the probability on the ground of frequency alone in favour of the former class being scarcely sufficient to define the regimen to be ordered. Intermediate, as it were, between these extremes of dietetic method may be mentioned a purely milk diet, very small quantities being given at frequent regular intervals, the amount being increased as improvement takes place. The milk may be peptonised, or mixed with lime-water or with effervescing water—soda, Apollinaris, etc.—or with a small quantity of farinaceous food, all designed to cause a looser coagulation of the casein. Others prefer to give three or four meals a day of beef powder or some finely divided dry proteid mixed with magnesia or prepared chalk, and others depend on frequent teaspoonful doses of strong meat essences. Each of these methods the writer has seen attended with success, and on the whole it may be said that the general opinion is inclining rather to oral feeding, at least after two or three days' abstinence or rectal injections. As the case improves a more varied dietary may be gradually introduced.

Of the special manifestations, pain more particularly calls for treatment, and for this purpose the various gastric sedatives may be tried. But since this symptom, as well as nausea and other sensory discomforts, are closely associated with the excessive acid secretion in the stomach, the correction of this condition goes far to allay the discomfort. For this purpose the bicarbonates of soda or potash (gr. xxx.) are most effective, and may conveniently be given with subcarbonate of bismuth (gr. xx.) and oxalate of cerium (gr. x.). Or, acid. hydrocyan. dil. ♏iij. liq. bismuthi et ammonii citratis ♏xxx., sp. chloroform. ♏v., aq. ad. ℥ij., the writer has found most efficacious, and to this, if need be, three or four drops of liq. morphinæ acetatis may be added. As a rule, however, unless the pain be very severe, or unless there be hæmorrhage, it is well to avoid opium and morphia. In the case of bleeding, their value is great in calming the patient, and in consequence favouring its arrest. Atropin (gr. $\frac{1}{100}$) may be given with a view to arrest the secretion of the hydrochloric acid, being repeated every four or five hours according as it is tolerated.

Constipation, which, as a rule, is extremely obstinate, must be overcome by enemata and laxatives such as cascara, or, what is perhaps generally preferable, Carlsbad salts. The vomiting is best treated by the measures just mentioned for the relief of pain, which may be supplemented by a sinapism applied over the stomach. If the hæmorrhage be very excessive, transfusion of normal saline solution should be at once resorted to, as this diminishes the risk of syncope and prevents the distressing thirst which is so likely to follow. Hæmostatics, so called, by the mouth are useless, but the subcutaneous injection of ergotinin, repeated every few hours for several doses, may be employed.

The subsequent anæmia supervening, as is generally the case in a state of chlorosis, requires iron, meat, sunlight, and the ordinary management pursued in this condition.

In all cases of healed gastric ulcer, except when the erosion is minute, there are the risks attendant upon the contraction of the cicatrix. These it is practically impossible to avert.

For the surgical treatment of gastric ulcer, see special article, p. 386.

Special Symptomatology and Treatment of Cancer of the Stomach

The onset of the symptoms characteristic of this disease is, like that of chronic gastric affections generally, insidious, and their exact commencement can rarely be indicated. In the cases occurring in early life the observations of Drs. Osler and M'Crae go to show a more abrupt commencement and more rapid course. In a small proportion of cases there is a history of dyspepsia for many years, and sometimes of very definite gastric ulcer, but far more frequently the patient gives no such account of his previous health.

The symptoms are those of a progressive indigestion, exhibiting much variation in the degree to which they are severally present, and it is from a combination of signs and symptoms rather than from any absolutely pathognomonic phenomenon that the diagnosis is inferred. In an appreciable number of cases the symptoms throughout, or until almost the end, are so

slight that the real nature of the affection is unrecognised.

Among the earliest evidences of gastric mischief is loss of appetite, which is frequently extreme, now and then exhibiting perhaps a transient improvement. It is usual for this anorexia to have existed for some time before the patient comes under observation, which event commonly follows the onset of some more serious symptom. Cases, however, do occur in which no impairment of appetite has been complained of. The distaste for food may amount to actual nausea, especially at the sight of meals. Gaseous eructations, chiefly of CO_2 derived from the fermentations taking place in the stomach, are sometimes most troublesome, and to the same cause is due flatulent distension of the stomach.

Vomiting is one of the most constant signs, being rarely absent when the pylorus is the site of the growth, being less frequent when the cardiac end of the organ is involved, and may be entirely absent when the whole viscus is infiltrated with a scirrhous formation. The relation of its occurrence to the ingestion of food is variable, often not until an hour or two afterwards, or may be at once when the mucous membrane is very irritable. Whilst generally persistent throughout the course of the malady, it is nevertheless subject to variation in severity; and in the last stages, when there is much dilatation, it may almost entirely cease.

The vomit contains the remains of very partially digested food, some of which may have been swallowed days or even weeks previously, and with more or less blood, dependent on the extent of the ulceration of the growth. The blood is usually altered in character, and of "coffee ground" appearance; but an extensive hæmatemesis of bright blood may occur, though far less frequently than is the case with gastric ulcer. On the other hand, the amount may be so small as to require the microscope for its detection. Should the growth be sloughing, then portions may be recognised in the vomit, which is also likely to contain sarcina, torula, and other organisms associated with delayed gastric digestion, and lactic acid and other fermentations. The odour of the vomit is occasionally most offensive, even where communication with the colon has not been established.

A valuable character of the contents of the stomach is to be found in connection with the hydrochloric acid of the gastric juice. The method of examination has been described (*see* article "Digestion and Metabolism," vol. ii. p. 370), and it has been observed in a very considerable number of cases that this acid is absent in cases of carcinoma of the stomach. So frequent is this that it becomes a sign of diagnostic value, inasmuch as no such constant absence occurs in gastric ulcer, with which cancer may be confused. Whilst repeated absence is strong evidence in favour of cancer, it cannot be said that the presence of the acid in the material withdrawn from the stomach under proper precautions excludes the existence of this disease. In the absence of hydrochloric acid, lactic acid is commonly found, but sometimes both are wanting.

Even more constant than vomiting is pain, although cases have not been unknown in which it has been, if not quite wanting, at least very slight; as a rule, it is severe and constant, of a dull, gnawing character, diffused generally over the gastric region, sometimes increased after food is taken, and very occasionally eased by the same, and seldom much relieved by vomiting. Some tenderness, perhaps extreme, is elicited on pressure over the epigastrium or gastric area generally, but there is seldom any specially localised point. Referred pains and tender points over the regions of the trunk and head are complained of; but "cutaneous tenderness is of less value in gastric carcinoma than in other diseases of the stomach, for cases of malignant disease are complicated by the presence of tender areas due to secondary deposits in other organs; moreover, in long-standing and exhausting diseases, pains often radiate far beyond the areas usually associated with the affected organ" (Dr. Hale White).

When the cardiac orifice is involved, the symptoms are those of œsophageal obstruction; there is dysphagia, and such food as is swallowed accumulates in great part in the gullet, whence it is regurgitated unaltered so far as gastric digestion is concerned.

The bowels are variable, though generally constipated, and the motions may from time to time be black from sulphide of iron derived from blood. Indican is a very frequent constituent of the urine; otherwise no abnormality is met with with any constancy, the diminished urea elimination being common to many wasting diseases with a small intake of food. Albuminuria and glycosuria may be present intermittently, and complete suppression may follow a copious vomiting; when also the gastric secretion is very considerable, the chlorides may temporarily disappear from the urine. An excess of creatinine has been noted. The tongue may be pale and moist, or furred, or dry and brown with red denuded edges.

The recognition of a gastric tumour is most uncertain. In many cases none is to be made out, though post-mortem examination may reveal one of considerable size. When situated at the cardiac orifice it is quite beyond detection, except by the passage of a stomach tube, and the same is sometimes the case with pyloric growths which may lie high up under the liver and margin of the thorax. Probably, on the whole, the mass is best to be felt when the stomach is empty. Tight lacing, by depress-

ing the viscera, may make the tumour easier of detection. The situation of the pylorus, or of any growth connected with it, is liable to be displaced if there be much dilatation of the organ, and especially if there be any proptosis; but, when palpable, a pyloric tumour is oftenest to be seen and felt in the epigastric or umbilical regions, rather more to the right of the median line, and much less frequently in one or other hypochondrium. A very imperfect notion of the real extent of the mass is obtained by manipulation when it is palpable owing to its connection with surrounding parts; it usually feels hard, and often nodular, giving a subtympanitic or dull note on percussion. As regards its mobility and the range of its movement with respiration the widest difference prevails, being quite fixed or fully movable, and shifting up and down with the movements of the diaphragm, or only perceptible on the deepest inspiration, or not even then. In those rarer cases where the entire stomach is implicated and the organ is much reduced in size with great thickening of the walls, or where the anterior wall is only or chiefly the seat of the growth, the tumour may be easily felt in the left hypochondrium, when it has been mistaken for an enlarged spleen, and with the characteristic alteration in the blood has led to a diagnosis of splenic leukæmia. The absence of any extension of the dulness upwards should serve to distinguish. The necessity for emptying the colon of scybala previous to examination is most important.

The physical signs of a dilated stomach usually coexist with those due to the tumour, and may indeed be the more prominent.

The small amount of food taken, the serious interference with the digestion of that which is retained, and perhaps also the prejudicial effects of the metabolic products of the growth itself, combine to produce a great impairment of nutrition, which is intensified by the more or less constant loss of blood and the distressing pain. Hence a progressive emaciation, which commences quite early in the illness, and great muscular weakness are characteristic of the disease. Few conditions lead to so extreme a wasting, should the patient live long enough. A profound anæmia is soon established and contributes to the intense debility, and explains the œdema of the feet and ankles usually met with, and also the thrombosis of the veins of the limbs occasionally seen. In advanced cases, especially those of the medullary form with frequent hæmorrhage, the characters of the blood resemble those of the pernicious type of anæmia, though the diminution in number of red corpuscles is seldom, if ever, so great; an apparent excess of red corpuscles has been seen when the fluid of the blood has been drained by excessive vomiting or hypersecretion in the stomach; some leucocytosis is to be observed, but nothing distinctive in the presence or absence of any particular form of white cell, although megaloblasts are wanting. In patients carefully observed and kept under uniform conditions a rise of temperature to 101° or rather higher is generally to be noticed. The cause of this is not satisfactorily known, but is generally ascribed to some toxin formed by the growth or produced in the course of the associated gastritis or local peritonitis. Shivering, with a rise of temperature to 104°, happens in a few cases. The general condition of ill-health as represented by these symptoms constitutes what is known as the malignant cachexia, the patient presenting a more or less characteristic appearance, of which the pallid, yellowish integuments is one of the most striking features. Patches of brown pigmentation on the face and extremities are also frequently observed.

The course of the disease is invariably towards a fatal termination, usually within a year from the time that the symptoms are declared, and not seldom within three or four months when occurring in the young. The scirrhous forms are somewhat slower in progress, and death may not take place for two years, or even rather more, whilst surgical interference claims in suitable cases still further to prolong life. Transient periods of slight apparent improvement, and even a slight gain in weight, after coming under treatment, are not infrequent. The patient usually succumbs to asthenia, hastened perhaps by a severe hæmorrhage; but a perforative peritonitis, or even pneumothorax from extension into the pleural cavity, may be the termination. Within a few days or hours of death a persistent hiccough is apt to set in, and the patient lapses into a lethargic state which deepens into coma and may be marked by a mild delirium; unable to take any nourishment beyond an occasional teaspoonful of liquid, and too feeble to vomit, life gradually slips away.

The progress of the case may be complicated by perforation of the growth into the peritoneal or pleural cavities, or into some part of the intestinal canal, most frequently the transverse colon, when the vomit becomes fæcal and a diarrhœa is likely to be set up. The pressure of the growth itself or of secondary nodules in the liver or lymphatic glands upon the portal vein and common bile duct may lead to ascites and jaundice; and its extension to the liver and even the head of the pancreas, or the occurrence of secondary deposits in the liver or lungs, will give rise to special symptoms. The obstruction, both structural and functional, at the pyloric orifice tends to induce some gastroectasis; and this will be greater in scirrhous stricture, though seldom so great as is caused by a non-malignant constriction. A rare complication is an umbilical fistula from adhesion of the growth to the abdominal wall. This lesion is much more frequent in tuberculous peritonitis or malignant

disease of the omentum. The occurrence of nodules around the navel has been already referred to.

Diagnosis.—In a large number of cases the diagnosis, certainly at first, is conjectural, in the absence, that is, of an epigastric tumour being detected. In a person over middle life in whom dyspeptic symptoms such as anorexia, nausea, constipation, with discomfort at the pit of the stomach, and a growing weakness and anæmia, are developing, the suspicion of gastric cancer should arise; and the significance of such symptoms would be greater if the patient have previously enjoyed good health. Should there be actual pain and vomiting, the diagnosis will be still more probable, and the presence of blood with the absence of hydrochloric acid in the vomit will make it all but certain, the recognition of an epigastric tumour affording conclusive evidence. In the absence of the last, it is an accumulation of the symptoms that must furnish the grounds for diagnosis, rather than any one, which may occur in other morbid states. Enlarged supraclavicular glands and nodules around the umbilicus are strongly suggestive.

The conditions from which cancer of the stomach have more particularly to be differentiated are gastric ulcer, non-malignant pyloric growth or stricture, and pernicious anæmia.

As a rule, the pain of ulcer is more localised, more severe, directly follows the taking of food, and is relieved by vomiting, although exceptions occur to each of these statements. In cancer the pain is diffuse, more constant, and is less influenced by the ingestion of food or its ejection. The emaciation in the former condition is also far less marked, and gastric ulcer may even coexist with a very fair bodily condition. The presence or absence of hydrochloric acid from the stomach contents is generally reliable to discriminate between these two conditions, though this may not be so in the early stage of cancer, when the other symptoms are also uncertain. The age of the patient is an important element, and also the duration of the symptoms, especially the hæmatemesis; and it should not be forgotten that a chronic ulcer may be associated with sufficient inflammatory thickening to give rise to a very distinct tumour.

In distinguishing between a malignant and non-malignant growth of the pylorus, attention should be paid to the extent of gastric dilatation, to the degree of wasting, the chemical character of the vomit, and the presence of cachexia. Important as the diagnosis in this case is with a view to operative treatment, it is often most difficult, and it is on the observer's unformulated experience that the final judgment often comes to be based.

The general similarity of the characters of the blood to those of pernicious anæmia renders the diagnosis of this malady almost excusable in those cases where the gastric symptoms, such as vomiting and pain, are in abeyance. Several cases have been recorded where the mistake has been made, and with some justification. The degree of leucocytosis in gastric cancer being but slight, should serve to distinguish it from leucocythæmia, even though the contracted, thickened stomach should simulate a splenic tumour.

Some cases of chronic gastritis in persons in middle life closely resemble malignant disease of the stomach, and the not infrequent development of cancer in an organ that has been the seat of long-standing catarrh makes the diagnosis more difficult, especially when no tumour is to be recognised. A similar difficulty also sometimes occurs in distinguishing between cancer of the stomach or duodenum and lead poisoning, remembering also that the two conditions may coexist. In all these cases, attention should be directed to the previous history and duration of the malady, the nature and seat of the pain and its relation to food, the occurrence of vomiting and characters of the vomited material, the examination of the blood, and the existence of a cachexia.

The signs and symptoms of primary duodenal cancer closely resemble those of the similar gastric affection, and a differential diagnosis is often impossible. The situation of the pain and tenderness, and of the epigastric tumour when palpable, are perhaps rather more distinctly to the right of the middle line than when the growth is strictly pyloric, but this is not always reliable. Inasmuch as the obstruction caused by the neoplasm tends to cause gastroectasis, symptoms indicative of stomach mischief soon occur, and the character of the vomit comes to have no diagnostic value, expect that the presence of bile or trypsin therein will show that the growth is below the biliary papilla, whilst the general symptoms of the malignant cachexia are indistinguishable in the lesions of the two organs. Jaundice from obstruction of the orifice of the bile duct is likely to supervene according to the exact situation of the growth.

Treatment.—Although so far operative procedure can only claim success in exceptional cases, it gives promise of improved results; but this very much depends on the earlier recognition of the disease than at present is usually the case, and an exploratory laparotomy now comparatively free from risk is to be reckoned as one of the means of ascertainment. Complete resection of the stomach, and excision of the pylorus, have each been performed with success and considerable prolongation of life, and even complete freedom from suffering, but the cases have been extremely few. Somewhat more promising are the records of gastro-enterostomy when the disease has been confined to the

pylorus; and a gastrostomy affords most relief and a short extension of life for cancer of the cardiac end. But the postponement of operation until a definite tumour is to be felt greatly diminishes the chance of benefit, since by that time extension of the disease to adjacent structures or secondary deposits is likely to exist. (*See* STOMACH, DISEASES OF, FROM THE SURGICAL ASPECT, p. 384.)

Since no other means of cure are possible, all that remains is to prolong life as far as possible with the relief of symptoms, and this may be done in some measure by attention to diet and with the help of drugs. Having regard to the impaired digestion that takes place in the stomach the seat of cancer, when the efficiency of the gastric juice is diminished by lack of acid, and there is probably pyloric obstruction and dilatation of the organ, and in any case impaired mobility, it is clear that the gastric contents are very apt to become, from abnormal decompositions, very unhealthy, and to that extent a source of irritation. Hence washing out the organ is distinctly indicated, and when this can be regularly performed every day or every other day, it affords the greatest relief to the patient even from the pain and sickness, and gives the best chance for the digestion of such food as is taken. The difficulties, however, are often great in pursuing this course, owing to the insuperable objections of the individual; for although no doubt lavage causes little or no discomfort when once the habit is acquired, it is distinctly unpleasant in its first practice to most people, and this especially so when begun on a patient who is seriously ill with malignant disease of the stomach, and promises of benefit will often fail to allow a fair trial of the method. If submitted to, it may be said that not even hæmorrhage contra-indicates its employment. The chief points to observe in respect to the food are that it should be given in small quantities at intervals of three or four hours: a little digested and passed on into the intestines is better than larger amounts which decompose and irritate; the bad appetite will generally prevent any overloading of the stomach. Considerable latitude may be given to the patient's own wishes as to what he takes, but it is well to avoid, as far as possible, fats and much sugar or starch food as well as vegetables, and the more nitrogenous the diet is the better. Fluid food also should only be given in small quantity. Minced meat, chicken or fish, and eggs are all permissible so long as they can be taken. Peptonised foods, including milk, Benger's food, plasmon, soups, and meat extracts come to be the nutriment that has to be relied on, and these may have to be supplemented by nutrient enemata or suppositories. Alcohol in the form of sherry, whisky, or brandy, or champagne iced, especially if there be much sickness, may be given in amounts proportioned to the habits of the patient and his condition. Fruit jellies or the juice of fresh fruits, and grapes, are often grateful to the sufferer.

The appetite may be improved and the digestion aided by giving full doses of hydrochloric acid with vegetable bitters, gentian, quassia, chiretta, or condurango, and pepsin may also be added for the same purpose. Distinct benefit follows this treatment.

Antiseptics to check fermentations in the stomach are only of moderate advantage: creasote, carbolic acid, resorcin, and many others are used, but salicylic acid is one of the best.

Sooner or later morphia has to be administered by mouth or hypodermically for the relief of the pain, but previous trial should be made of hydrocyanic acid in an effervescing form with bismuth, which is conveniently given in the form of liquor bismuthi et ammoniæ citratis, codeia, or of potassium iodide with bismuth, which sometimes gives distinct relief. Aqua chloroformi will sometimes answer the same purpose.

The vomiting, as already said, is best treated by lavage, otherwise the effervescing hydrocyanic acid and bismuth mixture, with or without a few drops of liq. morphinæ acetatis or of liq. cocain. hydrochlor., or iced champagne may be tried. It is sometimes well to encourage the vomiting by swallowing a tumblerful of warm water, which washes out the stomach; but the efficacy of many of these remedies will depend on whether the organ is dilated and whether it contains a quantity of ill-digested material.

The constipation, which is often very troublesome, may be met by laxatives such as cascara sagrada, or by simple enemata or glycerine suppositories.

Special Symptomatology and Treatment of Dilatation of the Stomach—Gastroectasis

The signs and symptoms of this far from uncommon morbid state exhibit a considerable variety in degree dependent on the extent to which the distension of the viscus has taken place, as well as in some measure on the primary causal condition, the specific manifestations of which will be complicated by those of the gastroectasis.

Physical Signs. — Some bulging over the dilated organ is generally perceptible, especially if the patient be at all emaciated. When the distension is considerable the line of the upper curvature may be seen in the epigastric region, with a depression just below the ensiform cartilage. The outline of the greater curvature is not always visible, but sometimes almost the entire contour of the organ may be apparent. When the condition is secondary to pyloric obstruction, and there is hypertrophy of the muscular coat, exaggerated peristaltic movements may be seen spreading downwards over the organ from left to right, and the stomach

may at the same time be felt to harden under the hand applied over it. These movements occur at frequent and irregular intervals, and may be excited by gentle irritation of the surface; they serve to indicate the limits of the distended viscus, and are most apparent when it contains food or gas.

The lower margin of the dilated stomach may be felt on careful palpation, unless the parietes be unduly thick, but this is a sign that is on the whole less certain than are the other results of physical examination.

Far more reliable is the evidence to be obtained by percussion, for by that means the outline of the stomach may generally be satisfactorily ascertained. Allowance must be made for the presence of food or liquid in the organ. The characteristic "stomach note" may be obtainable upwards into the axilla as high even as the fourth rib, and in that situation it is at once detected. The lower limit, however, may be very difficult to distinguish from the colon, which lies just below; but Sir William Broadbent has pointed out that the distinction may be made by auscultation, "the cardiac sounds, especially the second, being heard all over the area of resonance proper to the stomach, with a characteristic tympanitic consonance, which is lost the moment the stethoscope passes from the stomach to the colon."

One of the most distinctive signs of gastrectasis is a splashing sound audible on disturbance of the stomach contents, as by sudden pressure on the gastric region, or by shaking the abdomen; from time to time the sound is elicited in the course of the peristaltic movements of the organ.

The physical examination of the patient should be made both in the upright and recumbent position, and the several facts may be more precisely ascertained by the passing of an œsophageal bougie, and the position of the tip recognised by palpation through the abdominal wall; or the extent of the distension may be better defined by inflation of the stomach by gas such as may be liberated by swallowing in successive portions the constituents of a seidlitz powder suitably dissolved.

Symptoms.—The severity of the symptoms is not always proportionate to the degree of dilatation as shown by the physical signs. A considerable distension may exist with but little symptomatic disturbance. It is convenient to distinguish the manifestations directly referable to the stomach lesion from those which depend on the perversion of digestion and consequent malnutrition.

Of the former, vomiting is the most significant and the most constant. It usually occurs at intervals of twenty-four hours and longer, and frequently at the latter part of the day. The amount brought up is considerable, amounting to several pints, and contains a large proportion of food taken many hours previously. The material is extremely acid in reaction, and of sour odour, from the organic acids derived from the decomposition of the gastric contents; the bulk is largely increased by an excessive secretion from the glands. Sometimes the vomit is of a brownish colour, and it may contain altered blood as well as abundant microorganisms, of which sarcinæ and torulæ are the most numerous. It may continue to ferment after being voided if kept in a warm place, and forms a yeasty scum on the surface. The ejection of the material is commonly very sudden and forcible, and unaccompanied by retching or much nausea.

Gastric flatulence and gaseous eructations, chiefly of CO_2, derived from the fermentation process, is another marked symptom. The enormous formation of gas increases the distension of the organ, and though fluctuating in its intensity, adds considerably to the distress which its condition entails.

The extent to which discomfort or pain in the stomach is complained of varies much; sometimes they are scarcely existent, and they bear but little relation to the taking of food. Rather is it that pain is felt before vomiting occurs, and is relieved by the emptying of the stomach.

Owing to the inadequate passage of food onwards into the intestine, whether from the vomiting, or the pyloric stenosis, or from both, the patient tends to deteriorate in general health, and to lose weight from want of sufficient nourishment, however much may be actually swallowed. For the same reason constipation is complained of, there not being enough bulk of material to excite intestinal peristalsis. The excessive drain on the blood by the hypersecretion determines a thirst, the relief of which only adds to the distension of the stomach. The urine is generally scanty and concentrated, and contains an abundance of ethereal sulphates derived from intestinal decomposition. Vomiting of large quantities of fluid may be followed for some hours by anuria. In some cases certain cardiac symptoms, especially palpitation, irregular action of the heart, and even pain of an anginous character and breathlessness, are very distressing. They are mainly due to slight displacement of the heart and interference with its action by the dilated stomach, and the relief of the distension by eructations of gas or by vomiting removes the cardiac distress.

The retention of the ingesta in the stomach and the abnormal fermentation resulting therefrom may reasonably be supposed to lead to the formation of substances which are irritant and toxic. A catarrh more or less persistent is established in the mucosa, and the tongue becomes coated and the breath foul.

Foremost among the symptoms which may be ascribed to the absorption of toxic substances

from the stomach are headache, alterations in mental state varying from irritability to depression, which may be extreme. With this goes considerable physical prostration and disinclination for exertion, both muscular and mental. In the severest cases the torpor and lethargy deepens into coma, which may be fatal. Cutaneous eruptions of an erythematous or urticarial character have also been noted in the course of the malady, presumably toxæmic in origin. And to the same cause is perhaps to be assigned the vertigo which often occurs. A form of insomnia which sometimes arises is distinguished by the patient waking regularly after the first few hours' sleep, and remaining awake the rest of the night in spite of all ordinary efforts to sleep, and perhaps dropping off into a heavy slumber from exhaustion when the night's rest should have terminated. This has been attributed to flatulence, and if this can be relieved by rubbing the abdomen, walking about, a draught of a hot carminative, etc., sleep can be induced. It cannot be said that this symptom is in any way peculiar to gastroectasis, although it is distinctly characteristic of some perversion of gastric digestion, and is very liable to occur in persons the subject of mental anxiety or strain in whom digestion is delayed. One of the most interesting symptoms associated with gastroectasis, which the recent researches of Drs. Halliburton and M'Kendrick have gone far to show is toxic in origin, is the so-called "gastric tetany." It is not of very common occurrence, and is marked by contraction of the fingers or toes, or both, the spasm sometimes involving the arms and legs, and more rarely the muscles of the trunk, neck, and face. Alternating with the tonic seizures may be clonic convulsions, though these are sometimes very slight. The attacks are often preceded by severe pain in the stomach, and are occasionally accompanied by unconsciousness. Washing out the stomach or vomiting frequently induces the paroxysm. The coexistence of transient albuminuria has been occasionally noted, but this is not to be regarded as indicating the cause of the tetany to be uræmic in nature, but rather is it the result of the renal epithelium being damaged by the elimination of the irritant toxin.

In the rare cases of gastric dilatation of sudden onset, and usually terminating fatally in a few days without any obvious cause, and apparently of the nature of an acute paralytic distension with enormous hypersecretion, the patient quickly passes into a very grave state of collapse. The physical signs of the condition exist in a marked degree, vomiting and gastric pain are manifested until the prostration is far advanced, and the emptying of the stomach is rapidly succeeded by a further copious secretion of gastric fluid ; the skin is dry and shrunken, and the urine almost or quite suppressed.

Intermediate, as it were, between such cases as these and the more chronic forms just described are those which complicate acute infective diseases, in which the symptoms for the most part correspond to the description given, but are more quickly established, and perhaps sooner recovered from.

Diagnosis.—This should not be difficult, at least so far as the recognition of the existence of the dilatation. A careful consideration of the physical signs, of the character of the vomiting and nature of the vomit, and of the remote symptoms, should be sufficient to establish the diagnosis, though it may not always be easy to exclude extreme dilatation of the transverse colon. But it is otherwise as regards a diagnosis of the cause of the condition, and for that other circumstances have to be considered, such as the history, presence of an epigastric tumour, etc., some assistance being obtained by remembering that the cases of greatest distension are often due to non-malignant stenosis of the pylorus, and the cases of non-obstructive causation give physical evidence of more distension upwards, the stomach on the whole tending less to fall in the abdomen.

Prognosis.—Reference has been made to the usual fatality attending the very acute cases, and those of more chronic character are mainly influenced in their course and termination by the cause, death being due in malignant obstruction to other circumstances. Among the symptoms of serious import tetany is prominent, but even this may be diminished in its gravity by prompt treatment. Besides being directly responsible for a fatal termination, gastroectasis is not infrequently the immediate cause of death in persons the subject of cardiac degeneration, in whom the disturbance of the heart's action by the dilated stomach is, so to say, the "last straw."

Treatment.—Undoubtedly much may be done for this condition. Whilst cure is not possible, from the nature of the cause in some cases, relief is possible for almost all. The question of the treatment of an existing pyloric stricture is dealt with elsewhere, but for the dilatation itself, however it has originated, the main indications are to prevent accumulations in the stomach, and to check fermentation therein.

The vomiting is the natural effort to relieve the first indication, which is even more efficiently met by emptying the stomach with a tube at regular intervals, and subsequent washing out of the organ. This should be done once in the twenty-four hours, preferably in the evening, and the lavage should be carried out with several pints of water at a temperature of 85° Fahr., in which boric acid (4 drachms to the pint), or sodium bicarbonate in same proportion, is dissolved. By this means the decomposing food-stuffs are removed and their toxic effects are avoided, and at the same time the mucous membrane is given a chance of recovery. It is

not, of course, claimed that such a treatment will cure the dilatation consequent on a permanent pyloric stricture, but it goes far to do so when the underlying cause is atony and a chronic catarrh.

Carbolic acid or creasote in one or two minim doses, hyposulphite of soda, or sulphocarbolate of soda, grs. 5 to 10, made up with carminatives, are the most effective antifermentatives.

Much benefit in restoring the tone of the stomach may be derived from supplementing the lavage by abdominal massage with or without applications of faradic electricity, for five to fifteen minutes, of sufficient strength of current to cause distinct contractions of the abdominal muscles, one pole being placed on the stomach, and the other round towards the back.

The diet and feeding of such cases is of great importance. Sugar and starch foods, as being liable to ferment in the stomach, should be reduced to a minimum. Minced freshly cooked meat, peptonised milk, Benger's food, and plasmon are the most suitable, and should be given in small quantities at intervals of four hours, preceded with an occasional dose of dilute hydrochloric acid. All liquids should be given sparingly. Rectal feeding may be necessary at first to give the stomach as complete a rest as possible, the lavage meanwhile being continued, and this mode of nourishment is the only one feasible in the cases of acute dilatation. When the condition is only moderate in degree a diet restricted to lean meat and hot water may be most beneficial.

When the primary cause is atony of the stomach, strychnine, arsenic, and iron, with general tonic treatment and good hygienic surroundings, are indicated.

The surgical treatment of the condition may consist of excision of the pylorus, and union of the duodenum to stomach (pylorectomy), which is resorted to in favourable cases of pyloric new growth; or in non-malignant stenosis the orifice may be forcibly stretched. The dilated organ has been frequently reduced in size by making folds on the anterior surface, from the lesion to the greater curvature (gastroplication). The operation has been most successful in its results when combined with pyloroplasty. (See p. 394.)

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Diseases of the Stomach from the Surgical Aspect

It is assumed that the reader is familiar with the clinical methods of examination, both of the stomach and of the gastric contents, whether vomited or siphoned off through the stomach tube. It must be borne in mind that the infracostal portion of the stomach varies widely in different individuals, both as regards its extent and position; the greater curvature, for example, not infrequently extends to the level of or even below the umbilicus without any gastric symptoms, so that too much stress must not be laid on such variations in estimating the necessity or indications for surgical interference.

With regard to diagnosis, an *exploratory incision* may be required to confirm the diagnosis, to determine the question of operation, and to decide as to its nature. The occasional performance of an unnecessary exploration, while a matter for regret, is nothing in comparison with the loss of the opportune time for interference when it is omitted (Mayo Robson).

The mortality from exploratory operations should not exceed 5 per cent. They are most dangerous in the presence of advanced malignant disease. Unless, therefore, the patient is strong enough to undergo the major interference for which the exploratory operation is a preliminary, there is no object in its performance.

Reference may be made to the occasional experience that the exploration of an inoperable and apparently malignant tumour is followed by its disappearance, and the complete recovery of the patient. Such tumours are of inflammatory origin, and probably consist of perigastric adhesions and of induration around a chronic ulcer.

For mere exploration a small incision—sufficient to admit two fingers—is made in the middle line above the umbilicus.

Injuries and Diseases of the Stomach

Subcutaneous injuries usually result from blunt violence applied to the abdominal wall. Actual rupture of the organ is extremely rare, and is usually associated with rupture of the liver or spleen, so that the patient may succumb to shock and internal hæmorrhage before the

nature of the injury is recognised. The clinical features are those which attend all severe abdominal injuries along with pain and tenderness in the epigastrium, the presence of blood in the vomit, rigidity and retraction of the belly wall, and diminution or loss of the liver dulness. The symptoms tend to merge into those of perforation-peritonitis. The diagnosis is usually conjectural until an exploratory incision is made, and this should be undertaken without delay, unless contra-indicated by the general condition of the patient. The usual measures to alleviate shock are indispensable. When the belly is opened, the escape of gas and presence of gastric contents may confirm the diagnosis. Having discovered and closed the rupture of the stomach, the condition of the adjacent viscera should be investigated.

Penetrating Wounds.—These are caused by stabs, bullet-wounds, falls on spikes, and such-like injuries. If the stomach be empty and the wound a small one, there may be no leakage or hæmorrhage, and the wound may heal. Such has been the experience in recent warfare. In most cases met with in civil practice, the chances of natural recovery are very small indeed. The wound in the stomach is usually large enough to allow of the leakage of gastric contents, even if the stomach is said to be empty, and by involving a blood-vessel in the gastric wall or in the vicinity of the stomach, it may be attended with dangerous hæmorrhage into the peritoneal cavity. The clinical features may at first give little grounds for suspecting the gravity of the lesion. The character of the wound itself is often misleading: it may be small and contracted; its track may have become valvular from muscular contraction, or it may be filled with blood-clot. Its situation may appear to contra-indicate a gastric lesion; the author operated on a case where a gouge entered the belly below the navel, and slanting upwards penetrated the stomach close to the lesser curvature.

There is but little shock, the belly is tender, and the respiratory movements are diminished or absent; the vomiting of unaltered blood or of blood blackened by digestion is fairly constant.

The treatment is to enlarge the abdominal wound. If the belly cavity be penetrated, the wound is further enlarged for purposes of exploration. The presence of blood or of gastric contents confirms the existence of a visceral lesion. The leakage of blood or other fluid must be traced to its source. If the original wound be unfavourably situated, a fresh incision may be made in the middle line. Bleeding points are seized and ligatured. The stomach is drawn down into the field of operation, and if there is a wound in its wall it is closed by a double row of sutures. If the edges are ragged and bruised they should be paired or inverted. A second wound should be looked for, especially in cases of pistol-shot injury. The soiled peritoneum is wiped clean with gauze, and the belly wound is closed, usually without a drain.

In warfare the routine treatment is to place the patient under the influence of opium, to feed him exclusively by the bowel, and keep him under observation in case of complications, such as perigastric abscess.

Injuries of Stomach from Within.—The stomach may be perforated by objects passed down the gullet, as in the case of "sword-swallowers," or from the unskilful passage of bougies. Diagnosis is rarely possible without an exploratory incision.

The Effects of Corrosive Poisons.—Concentrated acids or alkalies corrode the stomach, so that it may give way either at the time or later by sloughing, or the destruction of tissue may subsequently result in cicatricial contraction. The corrosion chiefly affects the lesser curvature and pylorus, hence the cicatrisation leads to hour-glass stomach and to pyloric stenosis, and either of these may be complicated by stricture of the gullet. These after-effects are treated on the same lines as the corresponding lesions from other causes. It is essential for success that operative interference be undertaken before the patient's strength is seriously impaired.

Foreign Bodies in the Stomach.—The most common objects to be swallowed accidentally are plates of false teeth and bones of animals. The range of objects swallowed by performing artists, lunatics, and others includes knives, forks, nails, coins, etc. Impaction in the pyloric orifice is rare; the body either passes the pylorus or remains in the stomach, and it may do so for long periods without damage. Sharp-pointed objects may directly perforate into the peritoneal cavity or cause ulceration, perigastric adhesions, localised abscess, gastric fistula, or perforation-peritonitis. The clinical features vary widely, but in the main they resemble those of gastric ulcer and its complications. Large objects may be palpated through the abdominal wall. Metallic objects are demonstrated by the X-rays.

Treatment.—If the body is likely to pass the pylorus and bowels without damage, its passage may be rendered safer by a diet in which chopped-up worsted and milk puddings bulk largely. Daily observations are made with the X-rays, and the stools are strained over muslin. Bodies which are likely to do damage are best removed by gastrotomy.

Hair-balls, which are met with in girls who chew and swallow their own hair, may form a mass as large as a fist, or form a cast of the entire stomach. (In Mr. Swain's case the mass weighed 5 lbs. 3 oz.) They cause gastric pain, indigestion, and emaciation, and a tumour is to be felt in the epigastric region, which is possessed of such mobility that it has been

mistaken for a floating kidney. If the stomach is distended with air, the tumour may be demonstrated to move about inside the organ. The removal of the mass by gastrotomy is a successful operation.

The *pyloric obstruction of infants* is described in the article on "Gastro-intestinal Disorders of Infancy," vol. iii. It falls to be added, however, that the results of its surgical treatment are not so disastrous as are there stated. The pylorus has been stretched in infants of a few weeks old (six-eight) by Nicoll, Schmidt, Stiles, and others, and a gastro-enterostomy has been performed at a similar age by Kehr, Fritsche, and others, with permanent relief of symptoms. The former is probably to be preferred as being the less trying operation, the stretching being accomplished by means of bougies and dressing forceps.

Gastric Ulcer

The indications for the surgical treatment of gastric ulcer have been considerably widened of recent years, for experience has shown that not only can the complications of ulcer be dealt with successfully, but the healing and cure of the ulcer itself may be materially influenced.

Operative Treatment of Uncomplicated Ulcer.—In the majority of cases in which the ulcer has become chronic, it is only capable of being cured by surgical measures, and it may be our duty to have recourse to these because of the chronic ill-health resulting from the ulcer, the incapacity for earning a living, and the risk that the ulcer one day may perforate, or bleed, or become the starting-point of cancer. The nature of the interference is influenced by the combination of conditions which so frequently attend on ulcer—hyperacidity of the gastric contents, spasmodic contraction of the pylorus, which is often hypertrophied, and motor inefficiency of the stomach as a whole. Whether these conditions are responsible for the original formation of the ulcer, or are merely the result of its presence, is as yet uncertain, but we do know that their presence is inimical to healing, and that their removal is an essential condition for successful treatment. These conditions are most readily eliminated by providing a dependent exit for the gastric contents.

(1) *Gastro-enterostomy.*—The mortality of this operation has been reduced in recent years to 5 per cent. The results as recorded by Fantino, Mikulicz, Hartmann, Mayo Robson, and others are as follows:—There is no longer stasis of the gastric contents; the stomach empties itself in from three to four hours after a meal. If the organ was previously dilated, it tends to return to its normal size and position unless prevented by adhesions. Hyperacidity diminishes and finally disappears. If hydrochloric acid was previously absent or deficient, there is no change after the operation, because the deficiency depends on permanent atrophy of the gastric glands. The new outlet of the stomach is usually continent, as may be proved by distending the organ with air. In the majority of cases, pain, acidity, eructations, and vomiting disappear, the appetite returns, the bowels act regularly, there is rapid gain in weight, and the return to health is complete.

Relapse of the ulcer or the formation of a fresh one is not unknown, however; von Mikulicz records the occurrence of hæmatemesis three years after an apparent cure by gastro-enterostomy. In chronic ulcer of the duodenum also, gastro-enterostomy is indicated if the ulcer continues to cause symptoms after a fair trial of medical treatment.

(2) *Pyloroplasty.*—The object of this operation is to afford a free outlet for the gastric contents where the pylorus is narrowed as a result of spasm, muscular hypertrophy, or limited cicatricial contraction. In selected cases—where the pylorus is free from adhesions, and is not extensively scarred—it is an easier and slightly safer operation than gastro-enterostomy, and the functional results are similar. The stomach is said, however, not to empty itself so nearly within the normal limits, and if the organ was previously dilated it is more likely to remain so than after gastro-enterostomy. The relapse of symptoms, which is said to be more common after pyloroplasty, may be due to its having been performed in unsuitable cases.

(3) *Excision of the Ulcer.*—Inasmuch as excision does not get rid of the conditions associated with ulcer, unless combined with gastro-enterostomy or pyloroplasty, this operation is only practised when the ulcer is favourably situated, or there is reason to suspect that it has become the seat of cancer. If the ulcer be near the pylorus, its excision may form part of the operation of pyloroplasty.

Circular resection of the stomach and pylorectomy are only performed in cases of ulcer when it is impossible to exclude the presence of malignant disease.

Complications of Gastric Ulcer

Hæmorrhage—Gastrorrhagia.—In the *profuse hæmorrhage of sudden onset* the blood is most frequently derived from one of the larger arteries—coronary or splenic—exposed in the base of the ulcer, less frequently from one of the large venous trunks. In duodenal ulcer the bleeding usually proceeds from the gastro-duodenal artery. In a certain number of cases of profuse gastrorrhagia, even the most careful examination after death has failed to discover any gross vascular lesion. It is usually impossible to infer the size or nature of the bleeding point from the amount of blood lost or the rapidity with which it escapes. The situation of the bleeding point may occasionally

be conjectured if the ulcer can be located by the site of pain, its period of onset after food, the influence of posture, and the direction in which the pain radiates (Mayo Robson). With regard to treatment all are agreed that medical means should have a fair trial. If the hæmorrhage continues in spite of these, or if it recurs, then the question of operative interference should be discussed in consultation. After a second serious hæmorrhage, operation should be recommended as soon as the condition of the patient will allow of its being carried out (Mayo Robson).

The Operation for Gastrorrhagia.—The usual means are taken to alleviate shock, including the infusion of saline fluid, before, and it may be also during, the operation. The abdomen is opened in the middle line, the stomach identified, and its contents emptied by pressure into the duodenum. The stomach is examined for external signs of ulcer; failing these, it is laid freely open by an incision in its long axis. The upper and lower edges of the wound are widely retracted and the whole interior examined systematically. The posterior wall may be invaginated by means of two fingers introduced through an opening in the gastro-colic ligament. The duodenum may be explored with the finger, and may also be invaginated into the stomach. If no ulcer or bleeding point be discovered, one must fall back on putting the organ at rest by a gastro-enterostomy. If an ulcer be found the procedure varies with its accessibility. If it is on the anterior wall or lesser curvature near the pylorus, it is best to excise it. Only very small ulcers or bleeding points can be ligatured *en masse*. If the ulcer be inaccessible—on the posterior wall eating into the pancreas, or high up near the cardia — the bleeding may be arrested by means of the cautery (Mikulicz) or by packing with gauze, the end of the gauze being brought out at the opening in the stomach, and the edges of the latter joined to the parietes. In very feeble patients it is hopeless to explore the stomach; a gastro-enterostomy should be performed straight away.

In *small repeated hæmorrhages with progressive anæmia* there is no urgency; preparations are made, and a favourable opportunity selected for gastro-enterostomy, in the expectation that this will bring about the healing of the ulcer which is the source of the hæmorrhage.

Perforation.—This complication of ulcer is generally recognised as requiring immediate surgical treatment. The sites of perforation are well known, as are also the conditions under which it occurs, and the clinical features with which it is associated, so that we shall only draw attention to certain points which may be a source of difficulty. In about twenty per cent of cases there is more than one perforation. Although chiefly met with in anæmic young women, we have met with it in either sex up to the age of sixty. Perforation may be the first indication of the existence of an ulcer, the previous symptoms having been so slight as not to attract attention.

The most constant clinical feature is the sudden onset and persistence of severe pain and tenderness. Vomiting is more often absent than present. The shock is usually severe enough to be of use in diagnosis, but it is sometimes very slight and passes off quickly, so that when the patient is first seen the pulse and temperature may be normal. The belly wall is usually drawn in, hard, and immovable, but we have met with cases in which it was quite flaccid and moved with respiration. The escape of gas from the stomach may cause a fulness in the epigastrium and diminution in the liver dulness. The presence or absence of liver dulness, however, is of very little significance. Mere distension of the hepatic flexure of the colon may cause a marked diminution in the dulness. We must insist on the fact that in a considerable proportion of cases when the patient is first seen, his apparent well-being and the absence of complaint and of definite clinical signs may be most deceptive. While, on the one hand, we have seen patients absolutely felled, rolling about in agony, and only able to speak in whispers, we have seen others who were able to walk, to swallow liquids, and who were quite ignorant that anything serious had taken place. A minute perforation —and we have seen one no larger than an ordinary pin—or one occurring in an empty stomach, or in such a position that the contents are hindered from escaping by contact of the gastric wall with an opposing surface of peritoneum, or by adhesions, is attended with features which may leave room for doubt as to whether perforation has occurred or not. Similarly, where perforation takes place into the lesser sac, the shock is often evanescent, and the clinical features far from convincing. In both of these types it is quite possible for the patient to recover, and develop later a perigastric abscess. Finally, there is a clinical type: a patient who is known to suffer from ulcer, and who is suddenly seized with pain and collapse, and presents many of the features of perforation, and yet on exploration the wall of the stomach is found to be intact. These are probably instances of threatened perforation or concealed hæmorrhage. We have perhaps said enough to indicate that the diagnosis of perforation is sometimes one of considerable difficulty. When we are unable to say with certainty that there is NO perforation, we should not hesitate to make a small exploratory incision. The differential diagnosis of perforated ulcer from other critical abdominal lesions, such as ruptured extra-uterine gestation or appendicitis, is rarely difficult, and is of less importance, as a laparotomy is called for in any case.

Treatment. When to Operate.—The operation should be performed as soon as the necessary preparations have been completed. The only exception to this rule is where we believe that the perforation has taken place into an area walled in by adhesions. There are two reasons for delaying interference under these conditions: (1) because there is a considerable chance of spontaneous recovery, and if a perigastric abscess results, it may be safely opened at a later period; (2) because the ulcer concerned is usually unfavourably situated for interference, being mostly on the lesser curvature or posterior wall, and in obtaining access to it adhesions are opened up and there is risk of infecting the general peritoneal cavity (von Mikulicz).

The Operation for Perforated Ulcer.—The usual measures are taken to alleviate shock. The belly is opened in the middle line. The escape of gas and of turbid watery fluid confirms the diagnosis of perforation into the general peritoneal cavity. The parts exposed are injected and smeared with recent lymph. The peritoneal contents should be soaked up with gauze as the operation proceeds. We are often guided to the perforation by the gushes of gas and fluid which escape at each inspiration, or by the decided accumulation of lymph in its vicinity. If it be not found on the anterior surface of the pyloric segment which is exposed at the wound, the left lobe of the liver is raised by the assistant and the stomach pulled down so as to expose the body, fundus, and even the cardiac portion of the organ. At this stage it may be necessary to obtain better access by a right-angled cut across the left rectus, and it may be through the costal margin. If there is no ulcer on the anterior wall or lesser curvature, the posterior aspect must be explored by tearing an opening in the gastric colic ligament close to the greater curvature, and introducing two fingers into the lesser sac. No time should be lost in finding the perforation and proceeding to its closure. This is effected by means of a purse-string suture, or a series of Lembert sutures which will completely invaginate the area of the ulcer. If it be impossible to close the aperture efficiently because of the friability of the gastric wall or inaccessibility of the ulcer, a portion of omentum may be brought up to cover in the gap, or adjacent viscera may be stitched over it. The possibility of a second perforation must be borne in mind. The next procedure is to cleanse the peritoneum. If the cavity be infected as a whole, a large glass tube is introduced into the pouch of Douglas by a separate incision above the pubes, and the whole cavity is irrigated with salt solution at 105° F. The fluid is introduced by means of a funnel and flexible rubber tube. A large quantity of fluid is required, and the tube is moved with the fingers so as to reach in succession the parts in the immediate vicinity of the perforation, the space between the liver and diaphragm on either side of the suspensory ligament, the space between the stomach and spleen, the right kidney pouch, the right iliac fossa, the pelvis, the left iliac fossa, and left kidney pouch. When the fluid returns quite clear, the rubber tube is withdrawn and the wound closed, a considerable quantity of fluid being left in the abdomen. When the perforation is a small one and the leakage of gastric contents very limited, it is sufficient to mop up the fluid and lymph with gauze. The after-treatment is conducted on general principles. The pelvic drainage-tube is removed in twenty-four hours. The *immediate prognosis* chiefly depends on the length of time between the perforation and the operation, so that after twelve hours there are more deaths than recoveries. To a less extent it is influenced by the conditions attending the perforation. If the stomach is distended after a recent meal, if the perforation is widely patent, and if there is much retching, the escape of gastric contents is greater, the shock is more severe, and the infection more widely distributed.

Provided the shock and initial infection of the peritoneum be recovered from, the patient has still to run the gauntlet of various complications. The author has observed death on the fourth day from a second perforation, towards the end of the first week from septicæmia, during the second and third weeks from pleuro-pneumonia, embolism, etc., and as late as six months after the operation from pyelo-phlebitis and multiple abscesses of the liver.

Perforated Ulcer of Duodenum.—The clinical features closely resemble those following the perforation of a gastric ulcer. In some cases the pain is referred to the right hypochondrium. The tenderness and arrested movement of the belly wall are most marked along the right side of the abdomen, because the escaped fluids gravitate down the right side into the iliac fossa. In more than one-third of the recorded cases the diagnosis was made of acute appendicitis. On opening the abdomen, the incision being made through the right rectus, the peritoneal contents are found to be markedly stained with bile. There is little or no gas. The signs of peritoneal infection are most marked down the right side of the belly. To expose the first part of the duodenum, the liver and right costal margin are drawn upwards, the stomach and omentum displaced to the left, and the hepatic flexure of the colon downwards. The ulcer is usually found on the anterior wall, but may be on one of the lateral surfaces. The closure of the ulcer and cleansing of the peritoneum are carried out in the same way as in gastric ulcer. The mortality is even higher than in perforation of the stomach, only eight of the fifty-one recorded cases having recovered (Moynihan).

Perigastric Abscess.—Perigastric abscess usu-

ally results from the perforation of an ulcer into an area which is shut off from the peritoneal cavity. The ulcer is usually of the chronic variety, and the perforation is preceded by adhesive peritonitis. The situation of the abscess varies with that of the ulcer giving rise to it. The commonest situation is below the left vault of the diaphragm—subphrenic abscess—and is associated with ulcer higher up in the lesser curvature, or anywhere near the cardia. Abscess in the left hypochondrium projecting below the costal margin is usually associated with an ulcer in the anterior wall of the body of the stomach. Abscess in the lesser sac of the peritoneum, or in the substance of the pancreas or in the retro-peritoneal tissue, may result from an ulcer in the posterior wall. Subphrenic abscess on the right side may take origin from an ulcer of the duodenum. Abscess may also form anywhere in the vicinity of the stomach in cases of perforated ulcer treated by operation and in which the infective material has not been successfully removed.

Once a perigastric abscess has formed it may burrow and extend in various directions, may burst into the pleura or lung, or may rupture on the skin surface—it may be in the anterior abdominal wall or in the loin, and give rise to a gastric fistula. The abscess, as soon as it is recognised, should be opened and drained; it is rarely necessary to interfere with the ulcer from which it has originated.

Gastric Fistulæ.—These usually result from the perforation of an ulcer with or without the mediation of a circumscribed abscess. *External fistulæ* open on the skin, which may undergo partial digestion around the orifice. The patient may emaciate from loss of gastric contents. Small fistulæ tend to close, especially if the patient is fed per rectum; healing may be hastened by using the cautery. Larger fistulæ require operative treatment. On opening up the belly, the fistula may lead directly into the stomach or into an intermediate cavity. The dissection must expose the ulcer, which is then excised or its edges inverted and sutured. *Internal fistulæ* result from the perforation of the ulcer into an adjacent viscus, usually the colon; the stools contain food-materials and the patient complains of fœtid eructations and of vomiting of scybalous matter. To cure such a condition, the belly is opened, the viscera connected by the fistula are separated, and the respective openings closed by sutures.

Apart from ulcer, gastric fistula may result from stab and gunshot wounds, from operations on the stomach where the sutures have given way, and from ulceration connected with gall-stones.

Cicatricial Stenosis of the Pylorus and Dilatation of the Stomach.—These are not uncommon as a result of ulcer in the vicinity of the pylorus. The clinical features are those of gastric stasis and dilatation with cumulative vomiting. Splashing is readily elicited, peristaltic waves may be observed passing from left to right, and the greater curvature may be as low as the umbilicus or even the pubes. Such cases, although much benefited by washing out the stomach and other measures, can only be cured by surgical means. The arguments for and against interference must be discussed in relation to the peculiarities of each individual case.

The operation is, in the first instance, of the nature of an exploration. The pylorus is investigated. It is desirable in this connection that the surgeon should be familiar with the physical characters of the normal pylorus, otherwise he may conclude there is stenosis when this does not exist. The opening is normally closed by the sphincter muscle, which gradually yields and allows the passage of the forefinger, inserted by invaginating the anterior wall of the stomach. If the sphincter does not yield to the dilating force of the finger, it is certainly stenosed. Confirmatory evidence of an antecedent ulcer is usually forthcoming, in the shape of puckering of the serous coat or cicatricial induration or adhesions.

In order to relieve the patient we must either open up the pylorus or make a fresh communication with the intestine. Gastro-enterostomy yields the best and most enduring results. Pyloroplasty is easier, but is contra-indicated if there is extensive cicatricial induration or adhesions. Pylorectomy is performed if cancer be suspected and cannot be excluded.

The associated dilatation of the stomach usually disappears when the stomach has been rendered capable of emptying itself. It is only when it is very pronounced and combined with atony that recourse should be had to gastroplication.

Perigastric Adhesions.—Although adhesions involving the stomach may exist without giving rise to symptoms; they may, by interfering with the motor functions of the organ, by causing fixation and kinking of the pylorus and consequent dilatation, give rise to considerable suffering and ill-health. The symptoms may depend on stretching of the adhesions, consisting in dragging pain and discomfort after a full meal, relieved by lying down, or by wearing a belt, and aggravated by exertion; or they take the form of gastric stasis and vomiting as a result of obstruction at the pylorus. If relief does not follow on restriction of the diet, resting after meals, and the wearing of a belt, the question of opening the abdomen and liberating the adhesions (gastrolysis) may have to be considered. Slight adhesions are separated by the fingers, firmer bands are divided between ligatures. Less commonly the formation of dense adhesions fixing the stomach to the anterior belly-wall may give rise to a palpable abdominal

tumour which occupies the epigastric region and extends upwards beneath the costal margin on one or other side. There is considerable inflammatory infiltration of the muscles and fasciæ. The tumour is fixed, painful and tender, and unfits the patient for any occupation. Operation, although difficult, is strongly indicated. On separating the adhesions a "penetrating ulcer" is usually opened into, and it may require to be excised along with the infiltrated portion of the abdominal wall. The gap in the stomach is closed by sutures. The omentum may be brought up and fixed between the surfaces which were previously adherent. If it be impossible or dangerous to separate the adhesions, relief may be given by a gastro-enterostomy.

Hour-glass Stomach.—It is beyond the scope of this article to discuss the causation of this affection. We agree with Moynihan that it is practically always acquired, and is nearly always related to a pre-existing chronic ulcer. The ulcer leads to the hour-glass deformity by giving rise to adhesions, especially such as fix the central area of the viscus to the anterior abdominal wall, or by cicatricial contraction of its base, especially when the ulcer extends circularly around the body of the organ. The ulcer which is associated with hour-glass contraction may perforate, and it not infrequently becomes the seat of cancer. There is frequently pyloric stenosis in addition. The clinical features are usually those of dilated stomach supervening on a chronic ulcer. The hour-glass condition can usually be diagnosed with certainty if attention is paid to the characteristic physical signs pointed out by Wölfler, Jaworski, Jaboulay, von Eiselsberg, Moynihan, and Eichhorst. Most value attaches to the phenomena observed on washing out the stomach and on inflating it with air or gas. The two conditions for which hour-glass stomach is most liable to be mistaken are stricture of the lower end of the gullet and pyloric stenosis. The chief source of mistake hitherto has been that the existence of hour-glass stomach has been entirely unsuspected. The *treatment* of the condition is necessarily operative, but it is surrounded with difficulties. The whole stomach up to the cardiac orifice must be investigated, as there is considerable risk of assuming that the pyloric segment, which may alone be visible beneath the costal angle, is the entire organ, and, on the assumption that the dilatation of this segment is the cause of the symptoms, of performing a useless operation, such as a gastro-enterostomy on the *distal* side of the stricture. If the stricture is near the cardia and buried beneath the ribs, or if the cardiac pouch is surrounded by adhesions, it may be extremely difficult to perform any curative operation. Again, if there is a stricture at the pylorus as well as the hour-glass contraction, two operations will be required—one to eliminate each obstruction.

If the condition be one of uncomplicated hour-glass in an accessible situation with a narrow isthmus and without marked induration or adhesions, gastroplasty will suffice. If the two pouches sag downwards and almost touch below the isthmus and there are no extensive adhesions, a gastro-anastomosis should be preferred. If the pyloric outlet is also stenosed, a gastro-enterostomy should be performed in addition, especially if ulceration is still going on in the stomach. If an ulcer adherent to the abdominal wall be found, and on separating the adhesions a fistula is discovered, the thickened edges should be excised and the gap sutured at right angles to the long axis of the stomach. If the hour-glass cannot be remedied by gastroplasty or gastro-anastomosis, then one must fall back on a gastro-enterostomy, and the question then arises as to which segment of the stomach should be united to the jejunum. If the cardiac pouch be much the larger of the two, it should be selected, while if both pouches need draining, both of them are anastomosed with the intestine. If the hour-glass be the seat of cancer it should be freely excised, and the divided ends are then brought together by sutures (circular resection of the stomach).

Gastroptosis

Prolapse of the stomach, whether occurring alone or along with ptosis of other viscera, may not give rise to any symptoms. We are only concerned with cases in which there is decided impairment of the functions of the stomach. The chief symptoms are epigastric pain aggravated by standing and exercise, apparently due to stretching of the nerve plexuses of the stomach, and stagnation of the gastric contents necessitating the frequent use of the stomach-tube. On examining the patient, most importance attaches to the position of the lesser curvature and of the pylorus. If a large amount of water is swallowed in the erect posture, the stomach stands out prominently, and the lesser curvature and pylorus may be found to have descended as low as the umbilicus; the greater curvature may be found near the pubes or in the left iliac fossa. The pancreas may sometimes be palpated as a transverse cord a little above the level of the umbilicus. There is usually splashing on succussion after prolonged fast, and other evidences of dilatation of the stomach.

When sufficient relief does not follow on the use of a supporting bandage, massage (especially along with Weir Mitchell treatment), attention to diet, and occasional use of the stomach-tube, and the patient is unfitted for his or her occupation or the ordinary duties of life, recourse may be had to surgical interference. On opening the abdomen the stomach may be found to

occupy its normal position (the patient being recumbent and having been so for a variable period before the operation), but it is easily displaced downwards, the gastro-hepatic omentum is usually so attenuated as to be transparent, and the pancreas may be visible above the lesser curvature. The aim of the surgeon is to shorten the superior attachments of the stomach so as to prevent prolapse of the organ when the patient resumes the upright posture. This operation is known as gastropexy. Attention is then directed to the pylorus, and if it be narrowed or kinked, pyloroplasty or gastro-enterostomy should be performed, and if the organ is much dilated, its capacity may be diminished by gastroplication. (*See also* ENTEROPTOSIS, vol. iii. p. 120.)

CANCER

The surgical bearings of cancer of the stomach chiefly belong to the domain of diagnosis and treatment.

Diagnosis.—The outstanding clinical features are loss of flesh, anæmia, and dyspeptic symptoms. The stomach-tube usually demonstrates a greater or less degree of stasis of the gastric contents, especially if the pylorus is obstructed. Free hydrochloric acid is absent, except when cancer is grafted on a pre-existing ulcer. Although rarely present at an early stage of the disease, the formation of lactic and butyric acids is characteristic of cancer. Examination of the blood may show an association of decided anæmia and leucocytosis, the anæmia being characterised by a diminution in the proportion of hæmoglobin and an irregularity in the size and form of the red corpuscles. The absence of a palpable tumour is not to be allowed to affect the diagnosis; the belly wall may be too thick and rigid, the tumour may be too small, or—and this is especially the case in cancer of the pylorus and lesser curvature—it may be out of reach beneath the liver or costal margin. If cancer be suspected and there is no palpable tumour, recourse must be had to an exploratory incision, as it is our only sure means of making the diagnosis at a stage at which it is of real value. In the presence of a palpable tumour other possibilities must be borne in mind. It must be differentiated from tumours of the colon, omentum, gall-bladder, liver, pancreas, and abdominal wall, tumours resulting from perigastric adhesions related to a penetrating ulcer, and a floating kidney or spleen. Valuable information is often obtained by artificial distension of the stomach, but certainty may not be attained until the abdomen is opened.

Treatment.—So long as there is no specific remedy for cancer, removal of the growth affords the only possibility of cure. Whether this is possible and expedient can rarely be determined before opening the belly. Opinions founded on external examination may prove misleading. A small and movable tumour may be found to be hopelessly complicated by granular infection or metastases in the liver or peritoneum; and conversely, a large tumour may lend itself to radical removal and permanent cure. Even cachexia, although ominous, may not be a bar to a successful operation. Surgically speaking, the most hopeful cases are those in which the pylorus is obstructed at an early stage, because the patient is more likely to seek advice while the disease is still confined to its seat of origin.

An exploratory operation should only be undertaken if the strength of the patient is such as will enable him to survive removal of the disease; otherwise the exploration has no object.

Points to be Investigated on Opening the Abdomen.—The stomach is examined, and the presence of cancer excluded or confirmed. Difficulty may be experienced in differentiating between a chronic ulcer with induration and adhesions, and "ulcer-cancer"; in doubtful cases it is safer to regard and treat the condition as cancer.

Having identified the growth, the conditions for and against its radical removal must then be determined. Attention is directed to the following points:—

1. *The Extent of Involvement of the Stomach itself.*—This is estimated by inspection and by palpating both anterior and posterior walls of the viscus between the fingers: growths originating at the pylorus or near the lesser curvature tend to spread towards the cardia, often unequally on different aspects of the organ. Mere extent of the disease is not in itself a bar to operation, as shown by cases of successful removal of the whole organ, but extensive disease is usually associated with widespread infection of the glands and with infected adhesions, both of which are likely sources of recurrence.

2. *The Extension of Cancer to the Lymphatic Glands.*—This is estimated by the enlargement and induration of the glands. As in cancers elsewhere, the glands may be enlarged without being infected, hence the advisability in doubtful cases of having one of them submitted to microscopical examination at the time of the operation. The coronary glands along the lesser curvature, lying close to the stomach between the layers of the gastro-hepatic omentum, are most often infected in cancers of the pylorus and lesser curvature. They may be enlarged right up to the cardia, and they should be removed as a routine procedure, at any rate, up to the point where the coronary artery joins the lesser curvature. The chain along the greater curvature more often escapes, but in pyloric growths the glands immediately below the tumour should be removed. Infection of the deeper glands lying along the upper border and partly embedded in the substance of the

pancreas is a serious complication, as their removal adds greatly to the difficulty of a radical operation. Infection of the portal or retro-peritoneal glands contra-indicates such a procedure.

3. *Adhesions to and implication of adjacent organs* add to the risk of a curative operation and diminish the chances of its achievement. Those most likely to be involved are the colon, omentum, liver, pancreas, and abdominal wall. It is quite possible to successfully remove a portion of one or other of these structures, but it is rarely worth while to do so. Secondary growths in the peritoneum or liver contra-indicate removal.

Having investigated and determined the above conditions, the surgeon must thereupon decide whether he is to abandon further interference and close the belly, or proceed to the radical operation, or perform a palliative operation with the object of diminishing the sufferings of the patient and of prolonging his life.

The Radical Operation: Resection of the Cancerous Portion of the Stomach and Removal of the Associated Glands.—The sharp definition of the growth at the pylorus resulting from the absence of communication between the duodenal and gastric lymphatics allows of the section being made close to the tumour. On the cardiac side the growth usually extends in the submucous coat beyond its apparent margin, so that the section should be made at least $2\frac{1}{2}$ inches beyond this. The glands are removed along with the growth. There need be no fear of removing an amount of stomach beyond that which will permit of end-to-end junction of the divided viscera, as it is always possible to close each of them and re-establish communication by means of a gastro-jejunostomy.

Results of Resection. — The *mortality* is necessarily high, probably about 30 per cent in experienced hands; the chief causes of death are shock, peritonitis, pneumonia, and gangrene of the colon. The mortality will probably be reduced when cases are brought to operation at an earlier stage of the disease.

Permanent Cures.—These would appear to be quite as numerous as after operations for cancer of the tongue or rectum. As such we may regard those who are alive and well four years after the operation. Kocher, Jessop, Mikulicz, Billroth, Hahn, and others report cases alive and well after eight years. The histological characters of the cancer have a certain bearing on this question, the columnar epithelioma yielding the most favourable results because of its better definition and more accurate removal.

The Condition of those who Recover.—The majority regain their former health and put on weight rapidly—up to 50 or 60 lbs. The motor functions of the stomach are recovered, the organ is able to empty itself, and the lactic acid diminishes or disappears. The hydrochloric acid may or may not return; where it is permanently absent, the patient may suffer from gastric discomfort and may be incapable of digesting butcher-meat unless the acid is administered along with the food. If only a small portion of the stomach is preserved, the patient may be compelled to take small meals at frequent intervals.

Recurrence. — If this is going to occur it usually shows itself within two years. If it take place locally, the former gastric sufferings return and the disease runs its course as if no operation had been performed. If it take the form of secondary growths in the liver, peritoneum, or glands, the patient usually succumbs painlessly and without stomach symptoms.

Palliative Operations. — The tendency is to restrict these within narrow limits. *Gastro-enterostomy* is only to be performed if the patient suffers decidedly from pyloric obstruction, and yet has a fair prospect of living for some time. In many cases the vomiting ceases, the nutrition improves, and for a time the patient may feel quite well; but in a considerable proportion it gives no relief at all, or the patient never recovers his former health and strength. The mortality is fully as high as after resection, chiefly because it is performed on patients who are unable to stand the radical operation. The causes of death are the same as after resection. The prolongation of life varies very widely: the longest recorded survivals in undoubted cancer are $2\frac{1}{4}$ years (Mikulicz), $3\frac{1}{3}$ years (Strauss), and $3\frac{1}{2}$ years (Alsberg). The majority succumb to the original disease within a few months. Von Eiselsberg has practised *exclusion of the pylorus*, in addition to gastro-enterostomy, in order to prevent the discharge from the disintegrating cancer passing back into the stomach; this is carried out by dividing the stomach on the cardiac side of the growth and stitching up each open end of the gastric tube.

Resection of the cancerous segment of stomach as a palliative operation is recommended by Mikulicz and by Robson and Moynihan. According to Mikulicz the mortality is less than after gastro-enterostomy, there is greater relief from pain, there is more often increase in the body weight and strength, and the subsequent death is more often an easy one, being usually due to secondary growths. Robson and Moynihan affirm that a local extirpation, even if followed by recurrence, will probably prolong life for a greater period and in greater comfort than a gastro-enterostomy. It is only feasible, however, in a small proportion of cases.

Jejunostomy, with the object of putting the stomach at rest, when radical removal of the cancer or gastro-enterostomy is impracticable, has been strongly recommended by Maydl. Most surgeons prefer to close the belly under these conditions, as life can only be prolonged for a few weeks, and the state of the patient

with an intestinal fistula is pitiable in the extreme.

Ulcer-Cancer

There is usually a long-standing history of ulcer, and the gastric contents show the presence of free hydrochloric acid, frequently in excess. There is usually more pain and tenderness than in other forms of cancer. The growth most often develops in the region of the pylorus or at the constriction of an hour-glass stomach. The diagnosis is very difficult, the presence of a tumour not being conclusive evidence of cancer, and even after the abdomen is opened it may be difficult or impossible to differentiate the induration of simple ulcer from that which is due to the addition of malignant disease. The doubt may only be cleared up on microscopical examination of the specimen after removal. A radical operation is usually possible and successful.

Cancer of the Cardiac End of the Stomach

is either unattended with localising physical signs or it closely simulates the features of malignant stricture of the gullet. The question of gastrostomy may require consideration. In our own experience, while it averts starvation, and may prolong life for many months—the longest survival known to us being two years and five months—in the majority the patient drags out a miserable existence, and is unable to participate in any of the ordinary duties of life.

Tumours of the Stomach other than Cancer

Innocent connective-tissue tumours are very rare, and do not cause gastric symptoms unless they involve the pylorus or they are pedunculated and block this opening. The *myoma* is the best known; it may project into the interior of the organ and cause hæmorrhage, or project externally, giving rise to a slowly growing, firm tumour, sometimes of considerable size. It is rarely diagnosed, but when met with after opening the belly it should be removed along with the portion of stomach to which it is attached.

Sarcoma of the stomach is comparatively rare. Being associated with the same clinical features as cancer, it is usually mistaken for it until the specimen is examined after removal. Its treatment is conducted on the same lines. With isolated exceptions, the patient dies from recurrence of the disease.

Adenoma usually causes symptoms of pyloric obstruction, and is also liable to be mistaken for cancer. Sometimes it is decidedly pedunculated; more often it is sessile and impossible to differentiate from malignant disease. It is best removed by a radical operation.

Dilatation of the Stomach

Gastrectasis.—This, which is a common accompaniment of gastric affections, has been already studied in relation to ulcer and to cancer. It may also result from external pressure on the pylorus or duodenum, as by tumours of the pancreas, gall-bladder, liver, or retroperitoneal tissues. The pylorus or duodenum may be drawn upon or kinked by perigastric adhesions, especially those resulting from gall-stones, or by a movable right kidney. In a limited number of cases there may be no discoverable cause of the dilatation, and the condition is then regarded as a neuro-paresis. Such idiopathic dilatation sometimes supervenes on operations, especially those which concern the abdomen, and it may be a factor in causing death. The physical signs of gastrectasis are sufficiently well known. Treatment is primarily directed towards the removal of any existing cause, and this may necessitate surgical intervention. Failing the fulfilment of this indication, or in addition to it, it may be necessary to drain the stomach by means of a gastro-enterostomy, and the size of the organ may call for reduction by means of gastroplication.

Tuberculosis and syphilis of the stomach, and phlegmonous gastritis are beyond the scope of this article.

Operations on the Stomach

Gastrostomy.—The object of this operation is to establish a gastric fistula. It is indicated in malignant stricture of the gullet, in order to feed the patient; in innocent stricture, to permit of retrograde dilatation; in recent injuries, as from impacted foreign bodies and corrosive liquids, to rest the gullet and favour healing.

The method associated with the name of Witzel yields the best results. Under local anæsthesia the belly is opened by a vertical incision through the left rectus. The stomach, which in œsophageal obstructions is small, empty, and hidden behind the left lobe of the liver, is drawn out at the wound. Having selected an area between the curvatures, it is secured by a couple of sutures, the ends of which are held by an assistant. Having packed the operation area with gauze, an opening is made in the anterior wall in the centre of the area selected. The opening should be large enough to admit a flexible rubber tube, about No. 12 English catheter scale. The tube should project one inch or more into the interior of the organ, and it is fixed to the edge of the opening by means of a catgut suture. In order to invaginate the opening, two parallel folds of the anterior wall, one on either side, are then raised and approximated by a series of Halsted's sutures, two above and two below the tube; the sutures are knotted and the ends cut short. The invagination may with advantage be deepened by raising two similar folds on either side by a second series of sutures (Kader), the ends of two or more of these being left long to allow of their being passed through the edges of the parietal peri-

toneum, and thus fix the stomach to the anterior belly-wall. The external wound is then closed around the tube. Special care must be taken to fix the tube, as its untimely escape may be a source of difficulty; a reliable method is to use a silver ring which grips the tube, flush with the surface of the abdomen, and provided with eyes, by means of which it is secured by a broad tape encircling the body or by strips of plaster. The usual dressings are applied, and held in place by a many-tailed bandage. A funnel is then inserted into the outer end of the tube, and the patient is fed before leaving the table; the tube is closed with a wooden spill and secured to the bandage with a safety-pin.

After-treatment and Results.—The patient is fed every two hours or so with meat teas, milk, gruel, plasmon, somatose, eggs, and alcohol. The tube is taken out and cleaned once a week, and may be changed after a month or so for a No. 14 rubber catheter. When the fistula is no longer required, as after dilatation of innocent stricture, it closes rapidly on removal of the tube.

The author has performed eleven gastrostomies for malignant stricture: the shortest survival was one month—the cancer having penetrated the pleural cavity; the longest, nine months; the average of the series, three months. A patient operated on by Prof. Annandale survived two years and five months, cancer of the gullet being verified post-mortem. Although the fistula occupies a dependent point in the stomach, it is remarkably continent: the patient may cough after an abundant meal, even with the tube withdrawn, without a drop of fluid escaping.

Gastrotomy.—The steps of this operation have been described in the treatment of gastrorrhagia.

Gastropexy.—This consists in raising and fixing the stomach in cases of gastroptosis. As originally practised, the stomach was fixed to the anterior abdominal wall, but as this method of fixation may interfere with the motor functions of the organ, it is now preferred to tighten up the structures which normally support the stomach. A series of silk sutures are passed through the gastro-hepatic omentum in such a manner that when they are tightened up and knotted two horizontal folds result, and the lesser curvature of the stomach is suspended at a higher level. The first thread is inserted close to the hepatico-duodenal ligament, and includes the capsule of the liver; below, it is made to grasp the sero-muscular wall of the pylorus; the others range along towards the cardia (Bier). The gastro-phrenic ligament may also be tightened up. In one of our own cases the gastro-hepatic omentum was so thin and transparent that the sutures would not hold, but a satisfactory result was obtained by stitching the sero-muscular coat along the lesser curvature to the hepatic attachment of the round ligament and to the diaphragmatic peritoneum. The patient should lie for a month after operation.

Gastrorrhaphy.—This term is occasionally applied to the closure of wounds or of perforated ulcer of the stomach.

Gastrolysis.—This term refers to the separation of perigastric adhesions. It has been described under this head.

Gastroplication.—This operation is associated with Bircher's name, and is intended to reduce the size of a dilated stomach. As modified by Moynihan, a series of horizontal folds or tucks are made in the anterior wall of the organ by means of a number of silk sutures passed out and in through the sero-muscular coat. The sutures run from the lesser to the greater curvature, and when tightened up approximate the curvatures.

Pylorodiosis.—In this operation the pylorus is mechanically stretched and dilated. Loreta's method consists in opening the stomach near its outlet, and passing the fingers or a dilating instrument through the pylorus. Hahn's method, which is much safer and easier, consists in invaginating the anterior wall of the stomach by means of the forefinger, and pushing the latter into the pylorus; as the resistance of the sphincter is overcome, two or even three fingers may be inserted until the channel is well opened up. The procedure is contra-indicated if there is ulceration or cicatricial contraction.

Pyloroplasty.—This operation, which consists in open linear division of the narrowed pylorus, is associated with the names of Heinecke and v. Mikulicz. Having opened the belly, the pylorus is drawn out at the wound, and is packed round with gauze. Its anterior wall is divided longitudinally by an incision two inches in length, commencing on the stomach side of the pylorus, and prolonged through the latter by scissors. The upper and lower edges of the incisions are drawn widely apart, and are approximated by two rows of sutures in a direction at right angles to that of the original incision. A Robson's bobbin may be used as an internal splint.



FIG. 1.—Pyloroplasty for innocent stenosis of pylorus.

The contra-indications and results of this operation have been already described under Gastric Ulcer

Gastroplasty (Wölfler).—This operation implies the division of the strictured segment of an hour-glass stomach, and is carried out on the same lines as pyloroplasty. The incision

should be at least four inches in length. The operation is often rendered difficult by adhesions to the anterior abdominal wall, and on separating the adhesions a gastric ulcer may be opened into. To prevent the re-formation of adhesions, the right free edge of the omentum may be



FIG. 2.—Gastroplasty for hour-glass stomach.

brought up so as to lie between the stomach and the parietes.

Gastro-anastomosis or Gastro-gastrostomy (Wölfler).—This operation consists in making a free communication between the two compartments of an hour-glass stomach. It is carried out on the same lines as gastro-enterostomy, and the largest size of bone-bobbin may be used as an internal splint. The modification suggested by Watson consists in turning the pyloric segment over on to the cardiac portion, using the constriction between them as a hinge;



FIG. 3.—Gastro-anastomosis or gastro-gastrostomy for hour-glass stomach.

having fixed them together by sutures, the communication is effected through an opening made in the presenting surface of the pyloric compartment.

Gastro-enterostomy.—The communication between stomach and intestine is usually made with the first part of the jejunum—gastro-jejunostomy. The opening in the stomach is made at a dependent point close to the greater curvature. The viscera are applied to each other so that the direction of the peristaltic movements shall be the same in both.

The jejunum is either brought upwards in front of the colon and fixed to the anterior wall of the stomach—Wölfler's operation,—or it is brought up behind the colon and fixed to the posterior wall of the stomach—von Hacker's operation. There are countless modifications of the procedure, especially as regards the details of the anastomosis; we shall therefore limit our description to the operations above mentioned, either of which, when performed accurately, gives excellent results. The selection of one or other depends on the conditions present in each individual case.

Anterior Gastro-enterostomy (Wölfler's operation).—Having opened the belly and ascertained the exact condition of the viscera concerned, the first step is to identify the upper end of the jejunum. The omentum and colon are raised with the left hand, while the extended fingers of the right are pushed along the under surface

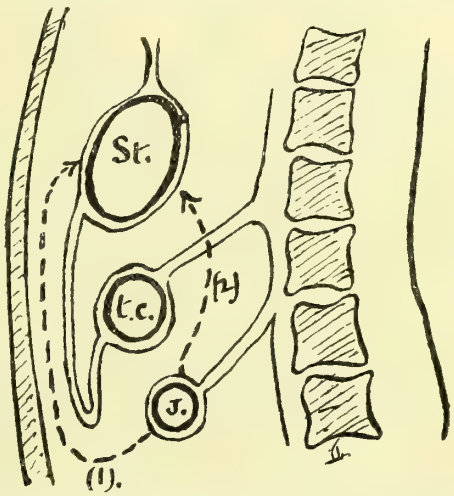


FIG. 4.—Scheme of methods of gastro-enterostomy, after v. Mikulicz. *St.*, stomach; *t.c.*, transverse, colon; *j.*, jejunum; (1) anterior gastro-enterostomy; (2) posterior gastro-enterostomy.

of the transverse mesocolon until they reach the vertebræ. The first loop of the jejunum, which lies immediately to the left, in the angle between the mesocolon and the vertebræ, is seized by the second and third fingers disposed like the blades of a scissors, and on pulling it forwards its connection with the fixed termination of the duodenum becomes evident. We have only once failed to find the jejunum by this method—in a case in which the colon was displaced and fixed by adhesions—and we were obliged to trace the small intestine upwards from the cæcum. Having identified the jejunum, a point is selected about twenty inches from its origin, and the loop is so disposed that its afferent and efferent limbs lie left and right respectively. The neck of the loop is encircled and constricted by a piece of narrow elastic tubing to prevent leakage. A point on the anterior wall of the stomach is selected, and the stomach as a whole drawn forwards into apposition with the jejunum, both viscera being

packed round with gauze. The "posterior" sero-serous continuous suture is inserted for a length of two and a half inches; on the intestine stitching close to and parallel with the mesenteric attachment, on the stomach the line of suture should run from below upwards and to the right, making with the horizontal an angle of about 45°, as it comes to be horizontal when the stomach is replaced (von Mikulicz). The ends of the suture are left long, and gauze is packed in along either side of the suture line to absorb any contents which may escape. Each

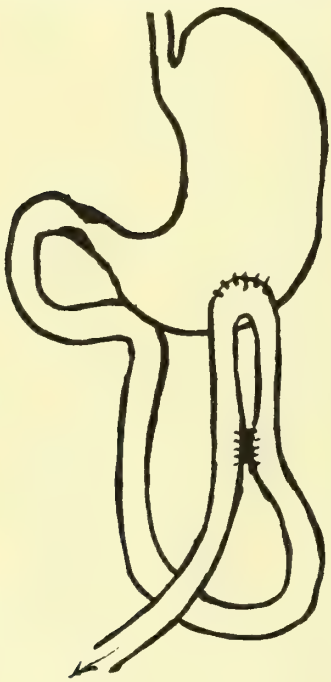


FIG. 5.—Anterior gastro-enterostomy and entero-anastomosis.

viscus is then opened 3 mm. from the suture line; any contents which escape are soaked up; the bleeding points are seized with forceps, and those in the stomach are ligatured. The edges of the openings are united with a continuous catgut suture passed through all the coats. A large Mayo Robson bobbin should be used as an internal splint; it is inserted before commencing the anterior suture. In very feeble patients the anastomosis may be more rapidly effected by means of a Murphy button, the female half being inserted in the stomach.

In non-malignant cases I usually perform an entero-anastomosis in addition to the gastro-enterostomy, making a communication between the afferent and efferent limbs of the jejunal loop about four inches below the junction with the stomach. This constitutes the most certain means of preventing the so-called "circulus vitiosus," or regurgitation of intestinal contents through the afferent limb into the stomach.

Posterior Gastro-enterostomy (von Hacker's operation).—After opening the abdomen, the omentum and transverse colon are turned upwards and laid on a sheet of gauze. A sagittal slit is made about the centre of the transverse mesocolon, carefully avoiding the larger blood-vessels passing to the colon. The slit is enlarged with the fingers so as to expose the posterior wall of the stomach, which is then drawn into the opening, or, still better, protruded by the fingers of an assistant from above. A few points of suture unite the stomach to the edges of the opening in the mesocolon. The jejunum, at a distance of from eight to ten inches from its origin, is then

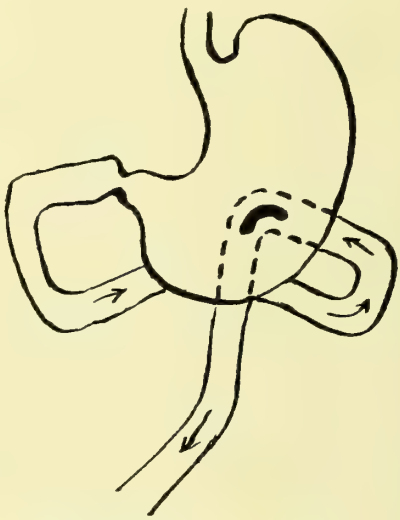


FIG. 6.—Posterior gastro-enterostomy. Von Hacker's operation.

anastomosed with the stomach in the usual way. A Mayo Robson bobbin is again useful as an internal splint.

In either of the above operations, it is recommended by Moynihan and others to remove an elliptical portion of mucous membrane in the case of each viscus, so as to prevent the formation of an obstructing ring and subsequent narrowing of the opening.

If the operation is followed by vomiting beyond that which can be ascribed to the anæsthetic, the stomach should be emptied and washed out by means of the tube.

Gastrectomy—Resection of the Stomach.—This is almost exclusively performed in cases of malignant disease. If it is not necessary to interrupt the continuity of the organ, the portion resected should be in the form of a wedge or ellipse, in order to avoid an irregular gap and a complicated line of suture. The gap is sutured at a right angle to the long axis of the stomach, so as not to narrow the lumen. In the majority of cases in which the continuity of the organ is interrupted, the resection involves the pyloric segment, and is spoken of as a pylorectomy, although a good deal more than the pylorus is taken away.

Resection of the Pyloric Segment—Pylorec-

tomy.—The incision is made in or near the middle line. Having opened the belly, our first concern is to determine the seat and extent of the cancer and its amenability to radical cure, especially noting the condition of the lymph glands, the nature of the adhesions, and the presence or absence of metastases. If the operation is to be proceeded with, the tumour is drawn forwards into the wound, to facilitate the separation of the omenta. In separating the transverse mesocolon, any enlarged glands are left attached to the stomach. The vessels on the stomach side are merely seized with forceps, but on the side of the colon they are ligatured. If the mesocolon is invaded by

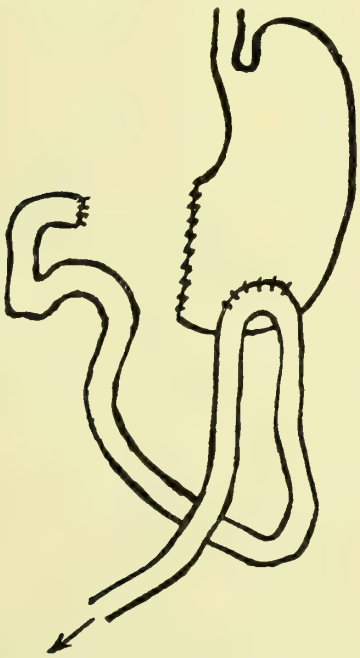


FIG. 7.—Gastro-enterostomy after resection of pyloric portion of stomach. Billroth's "second method" of pylorectomy.

cancer, it is questionable if the operation should be proceeded with, because tying the colic vessels imperils the vitality of the colon. If the right and left colic arteries be ligatured as well as the middle, the central portion of the colon is almost certain to perish, and must therefore be resected straight away—a serious addition to the operation. The lesser omentum is separated along the upper border of the growth, all glands being left attached to the latter. If the glands be enlarged they should be removed along the whole length of the lesser curvature, care being taken to secure the bleeding points, as they tend to retract beneath the costal margin. In clearing the pyloro-duodenal junction, the common bile-duct may be in danger if the parts have been displaced by contracting adhesions, as is frequently the case in ulcer-cancer.

When the growth is completely isolated it is drawn out of the wound, and the peritoneal cavity is shut off with gauze. The duodenum is to be divided half an inch from the margin of the cancer. The section is made between two clamp-forceps, and each cut surface is cleansed with a sublimate swab and wrapped in gauze. The pylorus is raised along with the growth, and the stomach is cut across two and a half inches beyond the margin of the cancer. The section is made between clamp-forceps; two pairs grasp the upper half, and other two the lower half, the assistant supporting the cardiac portion while the section is being made. The tumour is laid aside, escaped gastric contents are wiped away, and the cut edge of the stomach is disinfected. The forceps on the cut end of the stomach are relaxed sufficiently to allow bleeding from the vessels, and these are now secured and ligatured. The soiled gauze is replaced.

The further steps of the operation depend on the amount of stomach which has been removed. If it be possible to join the duodenum to the stomach, this is best carried out by Kocher's method. The cut end of stomach is closed by two rows of sutures, and the duodenum is inserted into its posterior wall, the communication being effected by sutures alone, as in a gastro-enterostomy, or by means of a Murphy button ($\frac{7}{8}$ inch).

Where the interval between the viscera is too great to allow of a direct junction, the cut end of each is closed, and communication between them is established by means of a gastro-enterostomy — "the second method of Billroth."

The suture lines are painted with iodoform cream, the gauze packing is removed, the viscera replaced, and the abdominal wound is closed without drainage.

If Kocher's operation has been performed, and there is regurgitation of intestinal contents and vomiting, this usually ceases if the patient is turned over on to his right side.

Complete Extirpation of the Stomach.—This operation is carried out on the same lines as an extensive resection. It is only practicable when a portion of the gullet below the diaphragm or a portion of the cardia can be preserved. The duodenum is joined to the lower end of the œsophagus; or, if this is impossible, the duodenum is closed, and a loop of the jejunum employed to re-establish the continuity of the alimentary tract. Although this operation has been performed successfully on several occasions, it is only called for in very exceptional cases, and can rarely be expected to afford a permanent cure.

Stomachics. — Drugs increasing the secretion of the gastric juice, such as aromatics, bitters, condiments (pepper, mustard, etc.), alkalies, alcohol, etc.; some act locally on the

gastric mucous membranes, others reflexly by stimulating the buccal mucosa.

Stomatitis.

Catarrhal 398
Aphthous 398
Ulcerative 399
Mercurial 400
Gangrenous (Cancrum oris) . . . 401
Parasitic (Thrush) 402

See also Children, Clinical Examination of (*Mouth and Throat*); Foot and Mouth Disease (*Local Symptoms*); Lung, Tuberculosis of (*Complications, Alimentary*); Mouth, Diseases of (*Inflammatory Lesions*); Mumps (*Symptoms*); Nursery Hygiene (*Mouth and Teeth*).

Stomatitis or inflammation of the mucous membrane of the mouth occurs at all ages, but is much commoner in infancy and childhood than at any other period of life. Several forms of stomatitis can be distinguished, and perhaps the most convenient classification is into five varieties: (i.) Catarrhal; (ii.) Aphthous; (iii.) Ulcerative; (iv.) Gangrenous, or Cancrum Oris; and (v.) Parasitic, or Thrush.

This classification is based chiefly on clinical appearances, and therefore cannot be regarded as final: it may be that wider knowledge may enable us to arrive at some more accurate classification on a basis of etiology, but at present we know so little of the factors which determine the particular variety of stomatitis in individual cases that it would be premature to attempt any such classification. Probably the commonest of the five forms of stomatitis is the parasitic, or thrush, and next in order of frequency would come the aphthous; but as the catarrhal variety represents perhaps an earlier and simpler condition pathologically, it is convenient to consider this first.

Catarrhal Stomatitis

A simple catarrhal inflammation of the mouth is common as an early manifestation of any form of stomatitis, but the condition to which the term is usually applied, and in which the inflammation does not pass beyond the catarrhal stage, is by no means common, at any rate amongst children.

As an occasional occurrence it is seen at any period of childhood or adult life. Some observers have described it as being particularly frequent during the first dentition, but the writer has been unable to verify this statement from his own observations.

Its causation in some cases is obscure, the local condition appears to be the expression of some general constitutional disturbance; in other cases it is associated with the exanthemata, particularly with measles; in others again it is due to some local irritation, be it the eruption of teeth, the presence of foul or broken stumps, scaldingly hot substances, or the overuse of tobacco.

Symptoms.—The inflammation affects only a portion of the mucous membrane, not the whole mouth. The part affected becomes at first redder than normal, and feels stiff and dry, causing considerable discomfort; at this period the mucous membrane may have a finely granular appearance, but in many cases, after a few hours, or perhaps a day or two, the mucosa becomes greyish white and opaque, almost as if it had been rubbed with silver nitrate. Rarely there is some very superficial excoriation or ulceration of the mucous membrane, and in a severe case the inflammation may spread to the deeper tissues, giving rise to some swelling and induration.

In infants and young children there may be some constitutional disturbance, the temperature being slightly raised and the child looking pale and ill. Some degree of salivation may be present where the stomatitis is extensive, and the discomfort which attends sucking and eating sometimes prevents the child from taking its food. But in most cases a catarrhal stomatitis is not a condition of any serious import, and it usually disappears in a few days with very simple treatment.

Pathology.—To whatever causes catarrhal stomatitis may be due, the histological changes are probably the same, to wit a dilatation of the blood-vessels supplying the mucous membrane, a proliferation and shedding of the superficial cells of the mucosa, and a small round-cell infiltration of the deeper part of the mucosa. No particular micro-organism has been associated with this condition yet, but it seems highly probable that some at least of the cases have a bacterial origin.

Treatment.—All that is necessary in most cases is to use some mild antiseptic application locally. For infants and young children, the mel boracis, or glycerine of borax, is suitable; for older children and adults, a mouth-wash may be used. Perhaps as good as any is the common combination of borax and potassium chlorate, which may be used in the following formula: ℞ Pot. chlorat. gr. vijss., boracis gr. x., glycerin. ʒss., aq. rosæ ad ℥j., as a mouth-wash. For the discomfort and hot smarting which are sometimes present the sucking of ice may be found useful. Care should be taken to avoid any food, liquid or solid, which may irritate the mucous membrane, and in some cases it may be advisable to keep the patient on "slop-diet" for a day or two. Any gastro-intestinal or constitutional disturbance must be treated according to the indications in the individual case. Carious teeth or other sources of local irritation must also receive attention.

Aphthous Stomatitis

Aphthous stomatitis, sometimes called "vesicular" or "herpetic" stomatitis, is extremely

common; indeed, according to the writer's statistics, more than half the cases of stomatitis which occur in children are of this variety; but statistics are not altogether reliable, particularly in comparing such a condition with thrush, which is so often part of some more serious malady that it is apt to be overlooked, if not in clinical examination, at any rate in out-patient records; and it seems probable that strictly accurate figures would show thrush or parasitic stomatitis to be the commoner of these two conditions.

Aphthous stomatitis is most frequent in children under four years of age, but is very rare under the age of six months. Although it occurs at any time in the year, it would seem to be more frequent during the cold months than in the summer.

Symptoms.—In many cases soreness of the mouth is the first symptom noticed, but it is not uncommon for marked constitutional disturbance to precede the local manifestations. The child feels ill, and looks pale and miserable; he is feverish, with headache and sometimes vomiting. These symptoms may last one or two days before there is any complaint of soreness in the mouth.

The oral appearances are very characteristic. On the anterior portion of the tongue, on the dorsum and at the edge, there are rounded, greyish-white opaque patches (aphthæ), somewhat like blisters, on the mucous membrane, surrounded by a narrow, dark-red zone of hyperæmia. These patches have a diameter varying from one millimetre up to half a centimetre, and vary in number from two or three up to fifteen or twenty; they are often slightly raised when they first appear. Similar patches are almost always present on the inner surface of the lips, especially the lower lip, and are sometimes present on the buccal mucosa, the hard and soft palate, and the anterior pillars of the fauces; rarely aphthæ are seen on one or both tonsils. After a few days these patches become shallow ulcers or erosions, generally with a greyish-white depressed base; occasionally this process goes further, patches coalesce, and the ulceration is deeper and more troublesome, but as a rule the shallow ulcers heal rapidly, leaving only for a short time minute grey scars in the mucous membrane.

With the appearance of these aphthæ, the mouth is often kept open and there is some drivelling of saliva, the infant refuses its food, and even older children may find trouble in eating, owing to the pain and smarting which accompany mastication. Even if no symptoms have preceded the onset of the oral symptoms the child now looks pale and "out of sorts," the temperature in a mild case may not be over 100°; in a severe case it may rise to 102° or 103° F. The submaxillary and sublingual lymphatic glands are sometimes swollen and tender, and in some cases, as a result of the drivelling of saliva, superficial erosions occur at the angles of the mouth having a white sodden appearance, a condition to which the French have given the name of "perléche." The duration of the symptoms varies from four or five days up to two weeks or even longer: probably the average duration is about a week.

Etiology and Pathology.—There can be no doubt that the depressed vitality which accompanies many disorders, especially gastro-intestinal disturbances in childhood, favours the onset of aphthous stomatitis, but the actual exciting cause of this condition remains unknown. Some observers have regarded it as comparable to cutaneous herpes, and have attributed it to a nervous origin, but there is little or no evidence in favour of this view. The condition rather suggests a microbic origin, but no specific micro-organism has been discovered; the writer has occasionally observed an eruption of pustules on the oral region of the face during the attack of aphthous stomatitis, an association which is at least noteworthy in connection with the microbic theory.

Even the nature of the aphthæ themselves is uncertain: by some they are regarded as analogous to a blister on the skin, the superficial epithelium being at first raised by an exudation of fluid, and then shed, so that the vesicle breaks, leaving a small ulcer; by others, it is thought that there is no exudation of fluid sufficient to form a vesicle, but that the appearances in most cases are consistent with a simple inflammatory proliferation of the epithelium with death of the superficial layers.

Treatment.—In the case of an infant, refusal of the breast or bottle may make it necessary to feed with a spoon, and for older children a fluid diet may be advisable for a few days, but it is important that the food should be nourishing and plentiful: milk, lightly boiled or poached eggs, custard, raw meat juice, or red gravy from underdone meat—all these are useful foods. Some antiseptic mouth-wash or application should be used frequently: for the younger children and infants the mel boracis or glycerine of borax may be applied with a soft piece of clean linen; or the following application may be used:—Potassii chloratis gr. x., boracis gr. x., mucilag. tragacanth. ʒij., glycerini ʒj., aq. ad ℥j. For older children and adults a mouth-wash of pot. chlor. gr. x., sanitas ℥x., aq. ad ℥j. is convenient. There is some diversity of opinion as to the value of potassium chlorate internally in these cases, but in the writer's experience it has seemed to be of very decided value for aphthous stomatitis in children.

Ulcerative Stomatitis

Ulcerative stomatitis occurs most often in children of four to twelve years, that is, at a later period than the aphthous variety. It

very rarely occurs in infancy, but is seen occasionally in adults.

Defective hygiene and ill-heath are important predisposing causes: many of the children who suffer from ulcerative stomatitis live in miserable surroundings, poorly fed and badly housed. The condition of the teeth also is an important factor: not only carious and jagged, but also dirty teeth are powerful exciting causes of ulcerative stomatitis.

The stomatitis which is due to mercury may be of catarrhal or of ulcerative variety, and may conveniently be mentioned here: it is seen occasionally in those who are employed in trades which necessitate the frequent handling of mercury, and sometimes as a result of administration of mercurial medicines: in its mildest form, with slight swelling and redness of the gums and some salivation, it sometimes follows the taking of only a few doses of mercury in those who possess some special idiosyncrasy to that drug; in this way the writer has known it to occur in infancy after only a few small doses of grey powder, although, as a rule, infants tolerate mercury well; in its more severe form, with ulceration of the gums, loosening of the teeth, or even necrosis of the jaw, and much fœtor, it is generally due to prolonged absorption of mercury, whatever may be the source; and it is important to remember that the individual doses given in such cases may be quite small, so that the cause is apt to be overlooked, and the administration of mercury continued under the impression that the quantity given is too small to account for the oral condition.

The affections of the mouth which occur in syphilis hardly call for mention here, for a diffuse stomatitis of syphilitic origin would seem to be very rare, although mucous patches, or ulcers, particularly on the tongue, are by no means uncommon, whether in congenital or in acquired syphilis.

Symptoms. — Ulcerative stomatitis usually shows itself first at the free edge of the gums about the teeth; the mucous membrane here becomes reddened and swollen, projecting slightly away from the teeth, and bleeding easily if touched. As the disease progresses there is actual loss of surface, the mucosa being ulcerated first around the teeth, and then in irregular and gradually extending patches. The ulcers usually have a dirty yellowish base, sometimes of a thick wash-leather appearance. From the gums the ulceration often extends to the inside of the lips and cheeks, which may be considerably swollen, but lack the brawny induration which is characteristic of cancrum oris. The writer's experience agrees with that of Henoch, that in many cases the ulceration spreads by contact; an ulcerated surface on the gum corresponds with a contiguous patch on the tongue or on the cheek.

With this ulceration there is almost always more or less fœtor of the breath, and this feature is so constant that the disease has been called "fœtid stomatitis."

In a severe case the ulceration may extend deeply, pus is seen welling up between the swollen mucosa and the teeth, and these latter may become loosened and drop out, or there may be some superficial necrosis of the alveolar margin of the jaw. Constitutional disturbance is usually marked in this disease: the child looks pale and ill, the temperature is raised to 101° or 102° F., and there is sometimes vomiting and headache. Some drivelling of saliva is usually present; the saliva both in this variety and in the aphthous form of stomatitis is alkaline, sometimes indeed strongly alkaline, contrasting herein with the constant acidity of the saliva in parasitic stomatitis or thrush.

The course of ulcerative stomatitis is almost always favourable, but in rare cases it proves fatal either by exhaustion increased by the difficulty in taking food, or, as it would seem, by some toxæmic condition. The relation of stomatitis to pernicious anæmia is uncertain, but of recent years it has been suggested that an ulcerated and septic condition of the mouth may, by a process of auto-intoxication, give rise to pernicious anæmia; and there can be little doubt that some of the constitutional symptoms which are associated with a severe and foul stomatitis are due partly at least to auto-intoxication.

Pathology.—In ulcerative stomatitis the early stages are probably identical with those occurring in catarrhal stomatitis, but the inflammatory process goes further: a disintegration of the mucous membrane and sometimes of the deeper parts occurs, and these are thrown off, leaving an ulcer, the base of which consists partly of disintegrating tissues, partly of fibrin. The process is due almost certainly to the action of micro-organisms, but beyond the common pyogenic micro-organisms, particularly the staphylococcus pyogenes aureus and albus, no specific micro-organism has been found.

Treatment.—The internal administration of potassium chlorate is especially effective in ulcerative stomatitis, producing marked improvement generally in two or three days. For an adult a dose of ten grains may be given every four hours; for a child of four years a dose of four grains every four hours will be sufficient. This drug may usefully be combined with nux vomica and cinchona, thus: pot. chlor. gr. x., tinct. nucis vomicæ ♏vijss., tinct. cinchon. co. ♏xx., acid nitrohydrochlor. dil. ♏v., glycerin ♏xxx., aq. ad ℥j. Potassium chlorate may be given in the form of tabloids, and a combination with cocaine may prevent the painful smarting which sometimes results from the chlorate alone. As a mouth-wash the mixture of sanitas and potassium chlorate mentioned above is suitable,

or a weak solution of permanganate may be used (liquor potass. permanganatis ♏x. in an ounce of distilled water); in very foul cases the liquor sodæ chlorinatæ (♏xx. in an ounce of water) may have a cleansing effect. By some it is recommended that the ulcers should be painted daily with a solution of alum (gr. x. to ℥j.) or of silver nitrate (gr. v. to ℥j.), or the glycerine of tannin may be used.

In all cases the local treatment must be supplemented by a generous diet, which will have to be given usually in the liquid form, and may comprise such food as has been recommended above for the cases of aphthous stomatitis: in some cases it will also be advisable to order stimulants in the form of port wine, brandy, or champagne.

Gangrenous Stomatitis (Cancrum Oris)

Of all forms of stomatitis this is by far the most serious, and happily also the most uncommon. Cancrum oris very rarely occurs in adults: it is seen most often in children between the ages of three and twelve years. Of 58 cases collected by Yates and Kingsford, 40 occurred within the first two years of life, 17 between the ages of five and fifteen years, and 1 at twenty-six years. A greater liability of the female sex was shown in the same series, 36 being females, 22 males

Any debilitating illness seems to predispose to this disease, but there seems to be some special liability to it after the specific fevers, particularly after measles; the writer has seen it also as a complication of tuberculosis. It may also follow some local injury; for example, in one case under the writer's care it followed the cauterisation of a small nævoid spot on the frænum of the tongue. A gangrenous stomatitis occasionally follows the prolonged use of mercury, as in a child under the writer's observation; and West alludes to a similar sequence, but it may be doubted whether these should be regarded as unusually severe cases of ulcerative stomatitis or as actual cancrum oris.

There can be little doubt that cancrum oris should be regarded as a specific disease, distinct even from the most severe form of ulcerative stomatitis; and there is reason to believe that it is due to a specific micro-organism, a bacillus described by Lingard as "thread-like, varying from ·004 mm. to ·008 mm., and about ·001 mm. in thickness." This bacillus is found in large numbers in the zone of tissue immediately adjoining the slough. Other observers have regarded the streptococcus, which has been found in some cases, as the cause of the disease.

Symptoms.—The disease appears in the mouth as a reddish and then a bluish-red area in the mucous membrane, which quickly becomes ulcerated, whilst the surrounding tissues become swollen and indurated; this area commonly appears first on the inside of one cheek, but it may begin over the alveolar portion of the jaw or on the inside of the lip. Holt mentions the occurrence of a similar process in the nose and in the external auditory meatus. A similar affection of the vulva, starting usually on the inner surface of the labia majora, is hardly less frequent than the affection of the mouth.

The indurated tissue rapidly sloughs, and a dirty brownish or black slough is left exposed on the inside of the mouth, whilst the infective process spreads outwards until the whole thickness of the cheek is tense and brawny, and the skin on the outside has a tense shiny appearance, with a bluish-red spot showing where the necrosis is approaching the surface. In this way the whole thickness of one, and rarely of both cheeks, may slough, and complete destruction of the cheek may occur, leaving a ragged opening into the mouth; or if the sloughing occurs over the jaw the bone may be exposed and necrotic. The spread of the disease is fearfully rapid: a few hours suffice to enlarge the affected area from a small spot up to an area the size of a shilling or larger. Saliva flows from the mouth, and a horrible fœtor accompanies the gangrene, but fortunately the condition is less distressing to the patient than might have been expected, for it is accompanied by little or no pain as a rule.

The constitutional disturbance is usually great; there is considerable pyrexia at first, but at a later stage the temperature is sometimes subnormal; the heart's action is rapid and feeble, and as the disease progresses the patient shows the grey colour and apathetic manner which go with a profound toxæmia.

It is important to remember, however, that in some cases there is remarkably little constitutional disturbance at first, and the child may play with its toys and take an interest in its surroundings when there is already actual gangrene of the tissues. Hæmorrhage of any severity seldom occurs from the affected part, owing, no doubt, to thrombosis of vessels occurring as the disease advances.

As a result, perhaps, of the inhalation of infective particles from the diseased part, broncho-pneumonia is a frequent complication, and diarrhœa may result from the swallowing of gangrenous material, or indirectly from toxæmia.

Prognosis.—The usual course of the disease is steadily downwards; the gangrene shows, as a rule, no tendency to spontaneous limitation, but extends rapidly until the child dies, usually of exhaustion. Rilliet and Barthez, in 21 cases, saw only 1 recovery; West, in 10 cases, saw 2 recoveries. The usual duration is from four to ten days. But it is encouraging to find that occasionally, even after sloughing has become so extensive as to involve the whole thickness of the cheek over a considerable area, the disease may cease to progress, either as a result of spontaneous limitation or as the result of

treatment. One caution, however, may be given in such cases: there seems to be a tendency to cardiac syncope during convalescence from this disease, a tendency which is perhaps explained by the necrotic foci in the myocardium, and other cardiac lesions which were found in animals inoculated with the bacillus described by Lingard.

Treatment.—It is all-important that treatment should be prompt and energetic in this disease: the saving of the child's life depends largely on early recognition and efficient treatment. It is now generally recognised that the only satisfactory method of treating cancrum oris is by complete removal of the affected part, and by the application either of powerful antiseptics or of the actual cautery to the apparently healthy tissue which is immediately adjacent to the sloughing area. These measures fall rather within the province of the surgeon than of the physician, and the present writer, therefore, can hardly do better than quote the very full directions given by his colleagues Mr. Watson Cheyne and Mr. Burghard:—"All the parts which are gangrenous must be clipped away; not only the soft parts, but the portion of the jaw affected must be removed, and this should be done till a surface which bleeds everywhere is exposed. Having in this way got rid of all the gangrenous tissue, pressure is applied and the bleeding arrested, and then strong nitric acid is painted over or rubbed into the raw surface. This is best done by means of a stout glass rod or glass brush. The acid is allowed to act for about ten minutes, fresh applications being repeatedly made during that time. When the surgeon is thoroughly satisfied that every portion of the disease is destroyed, the action of the acid is arrested by the application of a saturated solution of carbonate of soda, which is poured on the part until the acid is completely neutralised, as is shown when bubbles of carbonic acid gas cease to form. . . . The part should then be powdered with iodoform, and full-strength boracic ointment spread on butter-cloth applied with boracic lint outside it. The mouth or vagina should be washed out with sanitas and water, about 1 part in 12, several times a day. The wound will begin to granulate in five or six days, and then the weaker boracic ointment may be substituted."

Messrs. Yates and Kingsford record three cases in which recovery occurred after removal of the sloughs, followed by swabbing the adjacent tissues with a solution of perchloride of mercury (1 in 500); the parts were then dressed with lint soaked in a weaker solution of the same drug (1 in 1000). In one case this treatment arrested the disease when the application of nitric acid had been unsuccessful; but repetition of the treatment on several days may be necessary if the sloughing recurs.

The possible causal relation of streptococci to this disease has suggested the injection of antistreptococcic serum, and recovery has followed its use after other means had failed to arrest the gangrene (Cahall).

Every effort must be made to support the child's strength by nourishing food and stimulants. Egg-and-brandy mixture, yolks of egg mixed with beef-tea, custard, "trifle" (made with sponge-cakes, sherry, milk, and eggs)—any such foods may be used, and should be given at short intervals. Any signs of cardiac failure will call for further stimulation by strychnine, and perhaps digitalis or ammonium carbonate, and it may be necessary to keep the child in the recumbent position to prevent syncopal attacks.

Parasitic Stomatitis (Thrush)

Thrush is a disease chiefly of early infancy: it is only rarely seen in older children or adults. In infants it occurs most often as a complication of gastro-intestinal disorders, but is seen also in any enfeebled condition, and in adults at the end of phthisis or other exhausting disease. It is due to an invasion of the epithelium by a fungus, the saccharomyces or oidium albicans, which consists of oval cells and longer mycelium-like threads which dip down between the superficial layers of the epithelium, but not into the deeper part of the mucosa. The white patches consist of this fungus together with epithelial cells and bacteria.

Symptoms.—Small creamy-white raised specks which enlarge and coalesce are seen first, usually on the mucous membrane of the cheeks, then on the tongue, lips, palate, and fauces, making in a severe case a thick curd-like coating over considerable portions of the mucosa. At the edge of these patches the mucous membrane can be seen to be slightly reddened in some cases, showing that some degree of catarrhal stomatitis is associated with the parasitic growth; but in many of these slighter cases there is nothing whatever, so far as naked-eye appearances go, to suggest any inflammation whatever, and it may be doubted whether the parasitic invasion is necessarily associated with any stomatitis.

The mouth is usually rather dry than otherwise in cases of thrush; there is no tendency to drivelling of saliva. The saliva is almost invariably acid.

In severe cases thrush may interfere with suckling, and in this way hinder nutrition, but otherwise it seems to add little if anything to the constitutional disturbance due to the gastro-intestinal or other disorders which usually precede it.

Thrush rarely extends beyond the mouth, but occasionally it spreads down the œsophagus, and still more rarely into the stomach. Cases

are on record in which it has been found in the small intestine and in the cæcum, so that the popular idea of thrush "going through" the child has some basis in fact; but the redness about the buttocks which usually gives rise to this expression is due in almost all cases to the irritating fæces resulting from the associated gastro-intestinal disturbance, and not to thrush. It is said, however, that in rare cases thrush has occurred on the mucous membrane of the anus and genitals: the writer has never met with it either here or in the intestine.

Thrush seldom lasts more than a few days if actively treated, and is of little importance *per se*, unless it interferes with the taking of food in the case of a feeble infant. In the very rare cases in which it spreads down the œsophagus it has been known to interfere with deglutition (*vide* Gastro-Intestinal Disorders of Infancy, vol. iii.).

Treatment.—The mouth should be wiped out carefully after every feed with a soft piece of rag dipped in glycerin of borax, or the mel boracis may be smeared over the affected part. In some cases a spray may be more convenient, and a solution of sodium benzoate or of borax (gr. xv. to ℥j.) or sodium sulphite (℥ss. to ℥j.) should be used.

Great care must be taken to keep all teats and bottles which are used for feeding scrupulously clean, and it is advisable also to have the mother's nipples washed carefully with some boracic acid lotion after each suckling, as there is some risk of making these sore otherwise, and some observers have thought that the mother's nipple may become infected by the thrush parasite.

It is important to improve the child's condition by appropriate treatment of the diarrhœa or other disorder which may have predisposed to the thrush, and in some cases, both in infants and in older children, the appearance of thrush may be an indication for the use of stimulants.

Stomato-.—In compound words *stomato-* (Gr. στόμα, the mouth) means relating to the mouth; e.g. *stomatomycosis* (a parasitic disease of the mouth), *stomatonecrosis* (cancrum oris), and *stomatoplasty* (plastic surgery of the mouth).

Stomatodæum or Stomodæum.—In Embryology this term is applied to the primitive mouth; about the fifteenth day the foregut opens into it (through the disappearance of the bucco-pharyngeal membrane), and the anterior opening of the alimentary canal is thus formed.

Stomocephalus. — A teratological type in which there is cyclopia along with smallness of the lower jaw and mouth and the presence of a buccal proboscis.

Stone. *See* Bladder, Injuries and Diseases of (*Calculus Vesicæ*); Children, Clinical Examination of (*Urinary System*); Gall-Bladder and Bile-Ducts, Diseases of (*Cholelithiasis*); Kidney, Surgical Affections of (*Pyelitis, Stone in the Kidney and Ureter*); Lachrymal Apparatus, Diseases of (*Excretory Apparatus, Calculi*); Lungs, Pneumonokoniosis (*Stonemason's Lung*); Nose, Foreign Bodies (*Rhinoliths*); Pancreas, Diseases of (*Pancreatic Lithiasis*); Penis, Surgical Affections of (*Preputial Calculi*); Prostate Gland (*Prostatic Concretions*); Scrotum and Testicle, Diseases of (*Scrotal Calculi*); Urethra, Diseases of (*Calculi*); Urine, Pathological Changes in (*Urinary Calculi*); Vesiculæ Seminales (*Calculi*).

Stools.—Intestinal Sand.

See also Abdomen, Injuries of (*Symptoms, Blood in the Stools*); Beriberi (*Symptoms*); Blackwater Fever (*Symptoms*); Cholera, Epidemic; Cholera Nostras; Diarrhœa; Fæces and *Cross References*; Gastro-Intestinal Disorders of Infancy (*Diarrhœa*); Hæmatemesis; Intestines, Diseases of; Intestines, Surgical Affections of; Jaundice (*Obstructive, Signs of*), Liver, Diseases of (*Acute Yellow Atrophy, Symptoms*); Liver, Acute Hepatitis; Melæna; Mesenteric Glands (*Tuberculosis*); Sprue (*Clinical Features*); Sprue (*Hill Diarrhœa*); Typhoid Fever (*Etiology, Symptoms*).

This article deals solely with the subject of enterolithiasis. Other facts relating to the stools are dealt with in the article "Fæces," vol. iii., p. 241.

Enterolithiasis may be defined as the formation of concretions within the lumen of the intestine. A distinction must be drawn between true enterolithiasis and pseudo-enterolithiasis. In the latter condition, hard, scybalous, dried-up fæcal masses, gall-stones, or substances which, having been ingested, have remained undigested, are present within the intestine and are passed per rectum. The true intestinal concretions are usually of small size, like sand or gravel, so that the terms intestinal sand and intestinal gravel appropriately designate the condition. The formation of larger concretions—intestinal stones or enteroliths—is of still less frequent occurrence.

Intestinal Sand and Gravel (Sable intestinal, Gravier intestinal; Darmsand, Darmgries).—This condition is one of considerable rarity, and there is consequently but little literature on the subject. Attention was first directed to the condition by Laboulbène in 1873. He recorded 6 cases. In the majority of these the said particles consisted of a nucleus of undigested vegetable cells, around which there was inorganic material, mainly lime salts. In 1896 Mongour recorded the case of a young woman who passed in the stools yellowish-white calculi, varying in

size from an orange-pip to a hazel-nut, and composed of organic matter and of calcium and magnesium salts. In the same year Mathieu and Richaud recorded 2 cases: the first that of a woman of twenty-eight years, the second that of a woman of fifty-two. The sand in both cases consisted of organic matter and lime salts in varying proportions, and in the second case the sand had a resemblance to plaster. In 1896 Oddo likewise reported a case. The patient, a woman of fifty and of gouty stock, passed large quantities of intestinal sand, composed of organic fæcal matter and of salts of lime and magnesium. The largest concretions were of round form and the size of a small lentil. Of the four last-mentioned patients two suffered simultaneously from membranous colitis.

Dieulafoy in 1897 put on record 8 cases which had been under his own observation. The youngest patient was a girl of four and a half years, the oldest a lady of fifty. From a study of these cases and of those previously recorded, Dieulafoy concluded that there is an intestinal lithiasis, comparable to biliary and urinary lithiasis, manifested by sand, gravel, or calculi, consisting in each case of fæcal organic matter and of inorganic material in variable proportions, the inorganic matter being mainly salts of calcium and magnesium. He stated that in many cases intestinal lithiasis should be considered merely as an indication of chronic colitis and of membranous colitis, as in the majority of patients mucous casts were passed from the rectum simultaneously with the passage of sand or gravel. In other cases intestinal lithiasis is a manifestation of the gouty diathesis. In some of Dieulafoy's cases the passage of the sand was accompanied by few subjective symptoms of a mild character. Other patients suffered from attacks of severe abdominal pain lasting usually for some hours, and terminating on the passage of sand or gravel from the rectum. The frequency of these attacks varied greatly in different cases. In some they recurred every few days, in others only at intervals of some months. Dieulafoy's account of the clinical manifestations of intestinal lithiasis and his pathological observations are the most important that have been recorded, and although fresh cases have been reported since 1897, there has been hardly any noteworthy addition to our knowledge of the subject.

A case occurring in a lady, aged thirty, was recorded by Thomson and Ferguson. The sand when placed in water rapidly sank. It was of brownish-yellow colour and resembled uric acid. There was no trace of sclerenchymatous tissue or of magnesium, and the murexide test gave negative results. The sand consisted of 28·5 per cent of organic and of 71·5 per cent of inorganic matter, the composition of the latter being:—calcic carbonate 11·7 per cent, tricalcic phosphate 87·3 per cent, and insoluble residue (silica) 1 per cent. The pigment was thought to be a substance intermediate between the ordinary bile pigments and stercobilin, whilst, from the ready solubility of the sand in dilute acids, it was thought that the sand was probably formed in the ileum.

Two cases of intestinal sand in women between thirty and forty years of age were published by Eichorst in 1900. Both patients were affected with membranous colitis. The sand in the first case was of greyish-yellow colour and of earthy consistence, whereas in the second case the sand particles were globular or irregular in form, of a greyish-yellow or pale brown colour, did not exceed 2·8 mm. in diameter, were hard, and consisted mainly of calcium carbonate. Sir Dyce Duckworth and A. E. Garrod recorded a case in 1901. The patient was a woman aged thirty-three, of gouty stock. She suffered from intractable diarrhœa for two months before sand was found in the motions, but on every subsequent examination sand was detected. It resembled uric acid, was reddish-brown in colour, finely gritty, and contained 12·4 per cent of water, 26 per cent of organic material, and 61 per cent of inorganic matter, calcium phosphate being the chief mineral constituent. Two cases have been recorded by Barton (1901). In the one the sand resembled uric acid, with occasional small pieces like quartz or mica, and appeared to consist mainly of insoluble lime crystals; the other case was that of a boy who, it is said, passed from the rectum large quantities of sand, consisting of ammonia magnesium phosphate. Deetz (1901) records the case of a woman aged fifty. In this case there was no history of gout either in the patient or in her parents, and she was not affected with membranous colitis. The small brown sand particles were spherical or hemispherical in form, with pointed crystalline offshoots from them. They contained no cholesterin, and did not give the reactions of bilirubin or cellulose. The main inorganic constituent was calcium phosphate.

From a consideration of these cases, it appears that intestinal sand and gravel is most common in women between the ages of thirty and fifty, but that men and children may also be affected. In some cases the gouty diathesis seems to be an etiological factor of some importance, and in the majority of cases the patient suffers from colitis, diarrhœa, or constipation, or gives a history indicating some antecedent inflammation of the intestinal mucous membrane. The quantity of sand passed at any one time varies from an amount so small as only to be detected on careful examination of the fæces, to several teaspoonfuls, or, as in some cases, to "an enormous quantity." The passage of the intestinal sand or gravel may be unaccompanied by subjective symptoms, but in most cases there are attacks

of severe abdominal pain, recurring at variable intervals of time, and lasting usually for some hours, the pain being general throughout the abdomen, or more intense in some particular region, such as the right or left hypochondrium, the epigastrium, or the region of the cæcum. The pain may be accompanied by vomiting and flatulent distension of the abdomen.

The condition has to be diagnosed more especially from biliary and renal colic, appendicitis, and gastric ulcer. The passage of gall-stones per rectum may lead to error in diagnosis; but gall-stones, if numerous, are facetted and differ in composition from true intestinal concretions, which contain both organic and inorganic material, the latter being mainly calcium and magnesium salts.

On microscopic examination, true intestinal sand is readily differentiated from that form of pseudo-enterolithiasis in which the so-called sand consists of sclerenchyma. Sclerenchyma cells—hard, thick-walled vegetable cells—are present in abundance in pears, and the individuals who are reported to have passed "sand" consisting essentially of sclerenchyma cells have usually been in the habit of eating this fruit in more than moderate quantities. Cases of this nature have been recorded by Eichorst, Fürbringer, Delépine, Naunyn, Shattock, and others. The "sand" in these cases consists of small, irregular, pale yellowish or greyish-brown, exceedingly hard particles, and these when examined microscopically are seen to be thick-walled vegetable cells. The amount of sand passed in these cases is often considerable. In Shattock's case the patient would, after an aperient, "frequently pass as much as two ounces of the sand."

The formation of larger intestinal stones or enteroliths is likewise of rare occurrence. Of these it is usual to distinguish three forms:—(1) Concretions composed chiefly of phosphates, and formed around a foreign body such as a fruit-stone, dead parasite, or gall-stone, which constitutes the nucleus of the concretion. It is to ingestion of much indigestible vegetable material, or of earth or sand, that the formation of such enteroliths is mainly ascribed, and we may note that phosphatic stones, consisting mainly of ammonia magnesium phosphate, together with hair, bran, or other foreign substance, are of common occurrence in the intestine of the horse. (2) Fæcal concretions, consisting *mainly* of undigested vegetable material or dried fæces, partially impregnated with phosphates of calcium and magnesium. (3) Concretions resulting from ingestion of medicinal substances. These stones are usually composed of calcium or magnesium carbonate. The patient has as a rule previously suffered from hyperchlorhydria, and calcium and magnesium salts have been taken in large quantities over a prolonged period of time, and remaining in the intestinal canal have formed a solid mass of large size. In such cases of pseudo-enterolithiasis, calculi consisting of sodium bicarbonate, calcium carbonate, and magnesium carbonate are recorded by Langenhagen, and calculi of magnesium carbonate by Spillmann. Calculi of this nature may, moreover, be in part composed of salol (Leo), bismuth, etc.

The *treatment* of enterolithiasis must be directed to the relief of pain and to the cure of the causal condition. Dieulafoy recommends opium, intestinal lavage, appropriate diet, and mineral water such as that of Vichy. Eichorst's first patient was successfully treated by regulation of the diet, by abdominal massage, laxatives, and rectal injections of warm saline solution.

Storage. *See* Water (*Supply, Cisterns*, etc.).

Storax.—Prepared storax (*Styrax Præparatus*) is a purified balsam got from the trunk of a tree (*Liquidambar orientalis*) growing in Asia Minor; it contains styrene, cinnamic acid, styracin, etc.; it acts in the same way as the balsams of Tolu and Peru; it is used externally (mixed with olive oil) to kill pediculi, and rarely internally; its dose is 5 to 20 grains, and it enters into the composition of *Tinctura Benzoini Composita*.

Storer's Method.—A method of examining the rectal mucous membrane (by inspection): the finger is placed in the vagina, and the posterior vaginal wall is pressed backwards and downwards until the rectal wall is inverted and extruded through the anal aperture. *See* Gynæcology, Diagnosis in (*Rectal Examination, Methods*).

Stovaine.—The hydrochloride of alpha dimethyl-aminopropanol benzoate, a salt which has been used instead of cocaine, from which it differs in being a vaso-dilator and not a vaso-constrictor, and also in having a tonic effect on the heart. As a local anæsthetic to mucous surfaces it may be employed in a 5 or a 10 per cent solution; it may also be given hypodermically as a 0·5 per cent solution in distilled water (with the addition of adrenalin), and it is also of value for intraspinal injection. *See* Anæsthesia.

Stoves. *See* Ventilation and Warming (*Stoves*).

Strabismometer. *See* Strabismus (*Measurement, Strabometry*).

Strabismus.

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See also Amblyopia (*Congenital*); Auditory Nerve and Labyrinth (*Localisation of Lesion of Nerve Deafness*); Brain, Tumours of (*Diagnosis, Tumours of Crura Cerebri*); Brain, Surgery of (*Intracranial Inflammation, Leptomeningitis*); Gastro-Intestinal Disorders of Infancy (*Chronic Diarrhœa, Complications*); Hydrocephalus (*Symptoms*); Malingering (*Ocular*); Meningitis, Tuberculous (*Symptoms*); Meningitis, Epidemic Cerebro-Spinal (*Symptoms*); Nose, Nasal Neuroses (*Strabismus*); Ocular Muscles, Affections of (*Paralysis*); Syphilis (*Tertiary, Eye Affections*); Tetany (*Motor Symptoms*).

The visual mechanism which controls a pair of normal human eyes is capable of directing the visual axis of each to the same point of an object simultaneously. This point is termed the "point of fixation."

If the object be sufficiently remote (*e.g.* at the horizon), the infinitesimal convergence of the visual axes may practically be disregarded, and the eyes are said to be in their "primary position" with axes parallel.

By exercising the function of convergence the point of common fixation can be brought to within a few inches of the face, and by conjugate vertical, lateral, and torsional movements of the eyes a vast area of space is brought within the range of simultaneous fixation.

Definition. — Strabismus (squinting) is the term applied when the visual axes do not cross (or do not appear to cross) upon the point of fixation.

Strabismus may be

I. Apparent, or II. True

Apparent Strabismus.—1. *Epicanthus.*—In children an appearance of convergent squint may be due to a fold of integument overlapping each inner canthus and obscuring the nasal side of each globe—Epicanthus. If the redundant skin be pinched into a vertical fold, the deformity disappears. It commonly undergoes spontaneous cure by the forward growth of the bridge of the nose.

2. *Angle Gamma.*—The angle formed at the rotation point of the eyes between the optical axis and the line of fixation is termed the "angle gamma" (γ). Its average size is 5°. The centre of the cornea lying to the outer side of the line of fixation, it is evident that the anatomical relation of the cornea to the sclerotic may have an appreciable effect on this angle and on the apparent direction of the eyes.

The farther the centre of the cornea lies to the outer side of the line of fixation (*i.e.* the larger the angle gamma), the more an appearance of divergence will be given to the eyes, whereas the nearer it lies to that line, or still more when it lies to the inner side of it, an appearance of convergence will be imparted.

It is worthy of note that a large angle is usually associated with hypermetropia, and a small or negative angle with myopia. We shall see later that the apparent squint induced is just the reverse of what is commonly found associated with refractive errors in true squint.

Cases of apparent strabismus can be easily eliminated by any one of the methods mentioned later for the detection of true strabismus. For very young children the observation of the symmetrical position of the corneal images of an ophthalmoscopic mirror may be specially commended.

II. True Strabismus

may be *paralytic* or *non-paralytic.*

The former is due to paralysis of one or several of the external ocular muscles, and is usually recognised by observing—

(1) That the excursion of the eye being limited in the direction of action of the paralysed muscles, the *primary deviation* of the eye varies according as the eyes are turned more or less towards the affected muscle, and the *secondary deviation* is greater than the primary (*see* "Ocular Muscles," vol. vii.).

(2) That *diplopia* is complained of or can be soon elicited (by examination in the usual way with a red glass before one eye and a candle-flame as the test-object); that the distance between the images increases as the eyes turn towards the paralysed muscle, and if the sound eye be closed the affected eye exhibits false projection, mistaking the actual position of objects (*see* "Ocular Muscles," vol. vii.).

When we speak of strabismus ordinarily we mean the *non-paralytic* or *concomitant* variety in which—

(1) The angle of squint remains constant in whatever direction the eyes are turned, except during the act of accommodation with associated convergence, and in general convergence is less marked because less easily performed in looking up than in looking down. Further, for any one point of fixation the angle of secondary deviation is *equal* to the angle of primary deviation.

(2) Diplopia is not complained of. It can be elicited in most cases with considerable difficulty by special methods, but the distance between the images remains the same whichever way the eyes are turned.

The presence of a squint in pronounced cases is so obvious that it can scarcely escape the attention of any ordinary observer, but without thoroughly understanding what really constitutes squinting, a false diagnosis may be made where no squint exists, or a minor deviation, say of 5° or less, may be overlooked even

by a trained observer unless some special test is applied. There is a popular notion that to create a squint one has only to converge the visual axes forcibly towards the root of the nose. But since in this movement both eyes turn through an equal angle and are directed towards a common point of fixation, there is no actual squinting.

Latent Strabismus.—A tendency to squint may be latent but habitually overcome by voluntary effort in the interests of binocular vision. This may be termed a *superable* squint. Being thus disguised when both eyes are available for simultaneous fixation, no deformity is visible, and yet the patient may suffer much discomfort from the extra strain on one or more of the ocular muscles.

A squint which cannot be overcome by voluntary effort may be described as *insuperable*, and to this class the great majority of obvious squints belong.

The Detection of Strabismus.—*Alternate Exposure Test.*—The simplest means which can be employed without any apparatus is to direct attention to some small, remote, but well-defined object, preferably on a level with the eyes (or with the head thrown back it may be at a higher level, *e.g.* a chimney-top). The observer should place himself before the patient in such a position that he can easily watch the eyes without interfering with their lines of vision to the object selected, and then rapidly slip the back of his hand or an opaque card in front of one eye of the patient. If the remaining exposed eye possesses sufficient vision to see the object and has been exercising correct power of fixation, it will remain unmoved, but if it instinctively turns towards the object of regard, it reveals at once the faultiness of its previous position.

Let the cover next be quickly transferred from the first to the second eye, and note whether the former remains with fixed gaze on exposure or alters its position. If the muscular equilibrium of the eyes is perfect ("orthophoria"), no movement will be detected. If any movement of adjustment occurs, strabismus is at once revealed.

A converging eye must rotate out, a diverging eye must rotate in, a vertically deviated eye must turn down or turn up to correct the faulty direction of its visual axis. It is well to repeat the alternate covering several times in succession to secure the relaxation of a latent or superable squint, and to make certain that the patient is trying to fix steadily and not moving the eyes needlessly. A glance behind the obscuring hand or card will in most instances show that, if the exposed eye has adjusted itself, the covered eye has assumed the squint.

It now becomes evident that the movement of adjustment ("redress") is not due to the rotation of one eye alone, but to a conjugate movement of both eyes.

If one eye be very amblyopic or have a central scotoma, it may fail to correct its position through inability to see the object selected. In such cases the squint is usually very pronounced, constant, and "monolateral."

If the vision of one eye is decidedly keener than that of the other, the possessor learns instinctively to use the better eye by preference for fixation, and when both are uncovered, the less keen eye appears as the habitually squinting eye. There is usually an associated difference of refraction. There may be an unequal retinal capacity for vision.

Alternating Strabismus.—One may often observe a squinter spontaneously fixing first with one eye and then with the other, while squinting all the time. This is usually a sign of approximately equal acuteness of vision in the two eyes, and a good omen for successful treatment. By the alternate exposure test, as above described, the great majority of squints can be made to exhibit alternation, but only the spontaneous cases deserve the title "alternating."

A squint may sometimes not reveal itself until a definite stress is thrown upon the function of convergence.

Having applied the alternate cover test to the eyes, fixing a distant object, it should be repeated, while attention is fixed on a near object such as the tip of the finger or, better still, a pin-point held at ordinary reading distance. The alternate covering may now reveal a perfect maintenance of equilibrium or a true convergent strabismus, or the covered eye may appear to turn outwards by relaxation of convergence.

Variable Squint.—In many persons, but especially in children, the degree of squint may vary greatly at different times, being increased by emotions of excitement, surprise, joy or fear, by digestive disturbance or fatigue.

It may so completely disappear at times that it is difficult to reveal its presence by any method. This is one of the best proofs that squinting depends on a disturbance of central innervation and not on peripheral muscular inequalities.

To detect the smallest deviations in the visual axes and especially those which are latent, there is no surer method than the Maddox Rod Test ("Ocular Muscles"). The only difference between "heterophoria" and "squint" is in the application of the former term to designate the minuter deviations which can only be revealed by refined methods of investigation.

Classification of Concomitant Squints.—Looking to the relative position of the eyes, the usual classification is as follows:—

1. *Strabismus Convergens* ("Esophoria").—The visual axes turn inwards and cross in front of the eyes.

2. *Strabismus Divergens* ("Exophoria"). — The visual axes turn outwards and cross behind the eyes.

3. *Strabismus Ascendens or Sursumvergens.* —The visual axis of one eye trending to a higher level than the other; or

4. *Strabismus Descendens or Deorsumvergens.* —Where the visual axis of one eye trends towards a lower level than the other. These last two deviations are included in the term "hyperphoria," and all four are comprised in "heterophoria."

Clinically we recognise squints as—(*a*) Latent (either superable or too small to be noted by inspection), or (*b*) manifest (insuperable); (*c*) alternating, or (*d*) monolateral, including strabismus fixus; (*e*) constant, or (*f*) periodic (intermittent, accommodative, or variable). (*See* "Etiology of Squint," p. 409.)

Strabometry. — Various means have been devised for measuring the degree of squint present.

In the *linear* method, the well-directed eye is covered. The patient is asked to direct the squinting eye to a distant object. A suitably prepared millimetre scale is held close against the lower lid margin, so that the zero of the scale coincides with the vertical meridian of the cornea. The better eye is now uncovered; if, as usual, it assumes fixation of the distant object, the weaker eye turns in or out to resume its convergent or divergent misdirection. The number of millimetres of departure of the vertical meridian of the cornea to the one or other side of the mesial zero can now be read off on the millimetre scale and recorded. This method is of some value as a preliminary to the operative treatment of strabismus by advancement of a rectus muscle. But since in concomitant strabismus the visual lines cross at a definite angle, the size of this angle is the measure of the squint.

The *angular method* may be objective or subjective. Practically all the objective methods are based upon the relative position on the two eyes of the corneal image of a bright object. If both eyes be simultaneously directed towards a candle-flame, a small erect image of the flame will be reflected practically from the centre of each cornea. If the eyes be now slowly averted from the fixed flame, the images will appear to an observer to travel towards the corneal edge just in proportion to the extent of rotation of the eyes, until the reflections come no longer from the cornea but the conjunctiva and sclerotic of each eye. A similar observation may be made, and with greater exactitude, with an ophthalmoscopic mirror. If the patient be directed to fix his attention on the central aperture of the mirror, the visual line of the observed eye coincides with the visual line of the observer's eye, and the point of the cornea which is intersected by the visual line of the fixing eye is thus most accurately determined. The observation may be made with daylight, the patient having his back to a bright window, or with artificial light in the usual ophthalmoscopic manner.

If the corneal images occupy symmetrical positions, no squint is present. But if one corneal image is central and the other appears displaced inwards or outwards, upwards or downwards, squint is revealed. For very exact observations it must be remembered that the centre of the cornea does not often coincide precisely with the visual line, nor with the centre of the pupil. But for making a rough estimate of the deviation Hirschberg showed that, given fairly well-centred pupils of medium size (3·5 mm.), if the corneal image on the deviating eye appears to stand at the edge of the pupil, there is from 15° to 20° of squint, and that this estimate may be increased to 45° if the image rests on the corneal border.

Priestley Smith measures strabismus by means of a double tape and an ophthalmoscope. The one tape, a metre in length, is held by the patient against his temple, and extending to the handle of the observer's ophthalmoscope preserves that distance between them. A second tape, graduated and numbered, extends from the ophthalmoscope to the surgeon's disengaged hand, and passing between his fingers is weighted to keep it taut. The observer, throwing the light first on the fixing eye, notes its approximately central corneal reflection, and then turning the mirror towards the squinting eye, notes the eccentric corneal image. The patient is now requested to follow the line of the tape from the mirror towards the surgeon's free hand, which is gradually withdrawn in such a direction as may be required until the corneal reflex appears to the observer to occupy a normal position on the squinting eye. The rotation of the eyes thus measured by the tape represents the angular deviation of the squinting eye.

Another application of the same principle is found in the Maddox Tangent Strabismometer for one-metre distance, which can be affixed to the wall of any room. It consists of a long board graduated in tangents of degrees on either side of the central zero. A small candle is fixed just in front of this midpoint on the scale, and a string one metre in length depending from the same point affords a ready measure of the patient's distance from the scale. "Placing the patient facing the candle at the metre distance, the surgeon introduces his own head between the two, but a little lower down, about a foot away from the patient, and so that the root of his own nose is vertically under the rays of light which proceed to the patient's eyes. At once the tell-tale corneal reflections reveal which eye is the squinting one." The amount of squint is then measured by making

the fixing eye look along the scale from cipher to cipher until the corneal image on the squinting eye appears to be no longer eccentric. "Any vertical element in the squint can be similarly measured by the temporary adjustment of a vertical scale after measuring the horizontal element; the vertical scale being placed under the figure on the horizontal scale which has been previously settled on, the patient being made now to look at that figure on the vertical scale which brings the reflection to the fixation position" (Maddox).

Yet another method consists in holding a small candle-flame before the fixation point of a perimeter, and then moving the flame along the arc of the perimeter until the observer's eye, the candle-flame, and the centre of the cornea of the squinting eye are all in line. If the fixing eye has all the time been directed to the zero of the perimeter, the degree of deviation of the squinting eye can be easily read on the perimeter scale.

All of the above are objective methods, but in some cases where double vision can be elicited, a subjective method can be employed. For this purpose we may most conveniently use the Maddox five-metre tangent scale and rod test, the patient himself reading off the figure on the scale which appears crossed by the streak of light.

The Etiology of Squint.—Very few infants squint at birth. Uncertain movements, slight temporary nystagmus, and transient spasms of convergence are occasionally noted in the earliest months of life. Strabismus more often appears after the intellectual faculties have expanded sufficiently to allow of a desire for accurate visual impressions.

It must be remembered that whatever inherited tendency to harmonious co-ordination of the ocular movements a child may receive from its parents, it must learn for itself to direct its eyes simultaneously to a common point and to maintain binocular fixation upon that point even during movements. Javal has emphasised the extreme precision which is required to secure perfect coincidence of the retinal images. Out of this experience grows a sense of satisfaction in the avoidance of diplopia, a fuller appreciation of the solid shape, size, distance, and relative position of objects, and the "fusion faculty" once aroused becomes an instinctive habit. Such appears to be the normal evolution of binocular vision.

If there be perfect symmetry of the orbits, of the ocular muscles and their controlling nerve centres, if the refraction of each eye be similar and the capacity for retinal perception be equally acute, the habit of fusion must be easily acquired. But if one eye has for any reason a difficulty in playing its part in the visual duet, the faculty of fusion may never be properly developed or may be beyond the possibility of acquisition by that individual, and the eye which is under disadvantage is likely to become a squinting eye.

It is interesting further to note that after the fusion faculty has been acquired, it may be lost by disease. Thus it is a common experience that if an eye suffers a serious loss of vision, *e.g.* by the incidence of corneal opacity, or long-standing cataract, or destructive disease of the fundus, it tends to diverge from its fellow. In some persons, however, the habit of harmonious direction having been once acquired is so well preserved by the innervating centres that even blind eyes may maintain an appearance of normal equilibrium.

The most fanciful explanations are often put forward by the laity as to the cause of a squint. Some impediment to the vision of one eye while lying in the cradle, the evil example of a squinting nurse or playfellow leading to imitation, or some sudden shock or fright are among the commonest causes assigned. These may generally be dismissed as factors of no real importance. Let us look into the matter more closely.

Convergent strabismus is by far the commonest variety. Its most usual onset is between the ages of two and six, when a child is beginning to exercise accommodation with precision, learning to enjoy picture-books, or later commencing lessons.

Donders first drew attention to the frequent association of hypermetropia and hypermetropic astigmatism with this form of squint. He pointed out that in normal eyes the functions of accommodation and convergence go hand in hand. A young hypermetrope must exert his accommodation to focus even a distant object, and if the instinctive human habit of convergence of the eyes is not resisted at the same moment, he will find himself looking at a nearer point than he intended and receiving a double image of the object which he desired to fix. He must then either relax his accommodation and convergence and accept a single ill-defined image, or dissociate his accommodative from his convergent impulse, or maintaining accommodation and convergence to the extent required for clear definition must turn both eyes to the right or left by a conjugate lateral impulse so as to allow one eye to fix the object and let the other appear to do all the squinting. That this latter plan is the one usually followed in the production of convergent strabismus there can be no doubt. It affords at once an explanation of the reason why when both eyes are open the "fixing" eye is always the eye with the keener vision, why when one eye is covered the squint commonly "alternates" as mentioned in the earlier part of this article, and to some extent why it is "concomitant." While there is much truth in this ingenious explanation, it is not the whole truth. There

is not such a constant relation between accommodation and convergence. If there were, then all hypermetropes should squint, those with slight error squinting little, those with high refractive error squinting much. Actual observation does not bear that out. There may be hypermetropia and no squint. There may be little hypermetropia and much squint, or *vice versa*. By most persons the acts of accommodation and convergence can be performed separately or judiciously blended in such proportions as to maintain binocular fusion and avoid squint. The desire for single vision is the real safeguard.

Donders' theory appears, however, to be the true explanation of the large class of periodic (accommodative) squints in young persons. Carried further, it seems to explain the lessening of convergent squint which is often noted as age advances and accommodative power weakens.

Divergent strabismus may be explained in the same kind of way, especially when, as is so often the case, it is associated with myopia of unequal degree in the two eyes and with defective vision in one eye. A myope in looking at any object requires to exert no accommodative power until it lies between him and his farthest point of distinct vision, namely the point in space which represents the conjugate focus of the fovea of his fixing eye. The higher the myopia the less need for accommodation. It is not unreasonable to suppose that in some individuals this predisposes to a lessened activity of the associated centre for convergence. But owing to the fact that myopia is not often present in the first years of life, being gradually developed in adolescence or at least after the fusion faculty has been acquired, persons with myopia of equal or nearly equal amount and with good vision in each eye preserve the fusion faculty, and exercising convergence with little or no impulse to accommodation, do not squint. But if the myopia be of very high degree, the maintenance of the strong convergence required to maintain fusion at a plane so near the face (*e.g.* in reading without glasses) becomes irksome and is gradually relaxed. Further, if one eye be much more myopic than the other, or from any cause, congenital or acquired, has poor vision, it receives so little retinal stimulus to fusion that the innervation impulses sent from the centre of convergence become feeble by disuse. Thus a tendency to "insufficiency of convergence" induces first a latent divergence of the visual axes, then an occasional deviation outwards of the weaker eye during inattention, fatigue, indisposition, or attempted strong convergence for a near point, and finally, permanent divergent strabismus. The proper exercise of convergence giving place to a conjugate lateral movement, the squint may alternate voluntarily or be made to show alternation, just as in convergent strabismus, by alternate covering of the eyes.

Strabismus ascendens or descendens is more often latent than manifest. Like the commoner forms already discussed, it doubtless originates in some obstacle to facile fusion, some structural or functional asymmetry of the elevating or depressing muscles or their nerve centres. By the voluntary exercise of special muscular effort in the interest of binocular fusion it can often be overcome, and only manifests itself when an impediment to vision is present in or before one eye. Here again "alternation" of the squint can usually be demonstrated, the one eye ascending to fix, the other descending.

A combination of vertical and lateral strabismus is not uncommon.

The mobility of the eyes in squint varies in different individuals, and should always be tested. Many people imagine that the marked inversion of the deviating eye in convergent strabismus is comparable to talipes of the foot, and associated with a contracture of the internal rectus of the affected eye, or a palsy of the external rectus, and that in divergent strabismus these conditions are reversed.

Such a conclusion is never justified until the full range of possible movement of the eyes has been tested. This may readily be done by directing the patient to fix one's finger-tip, and then without turning his head to follow the finger with his eyes as it is moved to the right or left, up or down, or approximated to the root of the nose. The action of single muscles is thus fairly brought out, as well as the conjugate lateral, conjugate vertical, and convergent capacity.

In more refined diagnosis the angular excursion of each eye may be accurately measured by moving a fine test object along the arc of a perimeter, noting the limit of fixability, and comparing it with the normal range. In convergent strabismus it is not at all uncommon to find some restriction in the direction of action of each external rectus, but (except in the rare condition known as "strabismus fixus," in which there is apparently some congenital adhesion to the inner side of the globe restricting movement) each eye can usually be turned voluntarily outwards, and there is no rigid contracture of the internal recti.

Similarly, in divergent strabismus we can usually demonstrate readily that each internal rectus is well able to rotate the eye towards the nose under a conjugate lateral impulse, and that it is to the weakness or instability of the function of convergence that the deformity must be assigned.

The State of Vision in the Squinting Eye.— An eye which habitually squints has almost invariably a higher refractive error and poorer vision than its fellow, even with a correcting glass. Some are congenitally amblyopic. Some

have a central scotoma and are incapable of vision with direct fixation under any circumstances. Others have obvious disease of the media or fundus. All of these conditions lessen the retinal perception and facilitate the mental suppression of the diplopia, which might otherwise be expected to annoy the squinter.

The question has often been discussed as to how far the defective vision is the cause or the consequence of squinting. The answer seems to be that in a majority of cases it precedes the squint and is an important factor in its production by interfering with the fusion faculty. But considering the great improvement of vision which can be sometimes secured by solitary systematic exercise of a squinting eye, there can be little doubt that the defect may be increased and the squint aggravated by disuse of an eye (amblyopia exanopsia).

The Treatment of Strabismus.—The ultimate object is the development or encouragement of the fusion faculty; and the earlier it can be applied the better the prospect of cure.

Optical Treatment.—The first need for eyes capable of fixation is the correction of any refractive error, in order to secure defined retinal images, and in hypermetropia to relax accommodative strain.

In convergent strabismus the accommodation should be paralysed with homatropin or atropin to estimate the total hypermetropic or astigmatic error, if any, and should be kept paralysed for some time (three or four weeks at least) to break the habit of persistent accommodation and to let the wearer depend on the glasses. The effect of this treatment is most marked in accommodative strabismus, the squint often disappearing as soon as the glasses are put on, but reappearing when they are removed if fixation is attempted. Their constant use, however, often breaks the squinting habit, and these cases generally gain greatly in æsthetic appearance, and a few actually acquire binocular vision.

Cases of unequal myopia and of anisometropia associated with a tendency to divergent strabismus (if capable of maintaining convergence by voluntary efforts) often derive great benefit also from the regular use of correcting glasses.

In a large proportion of cases the defective vision of a squinting eye prevents it from utilising fully the optical benefit conferred by the spectacle lens, and the next stage of the treatment consists in the systematic, preferential, or solitary use of the feebler eye.

Treatment by Solitary Exercise.—In convergent strabismus this may be secured to a certain extent by continuing the application of atropin to the good eye but not to the weaker one. The latter then retains the advantage of accommodation, and may now become the fixing eye by preference. To ensure this with more certainty, it is better to cover up the good eye with a shade so accurately adjusted to the contour of the skin around the orbit that this eye cannot be used at all. The refractive correction must at the same time be continued to the uncovered eye. The immediate effect of this is merely to transfer the squint to the excluded eye without actually lessening its amount, and if that were all, the method would be valueless, but the real object of the treatment as now applied is to stimulate the use of the bad eye and induce in it a desire to play its part subsequently in vision with both eyes open. To be most effective the shade should be worn constantly. Javal of Paris has devoted many years of assiduous labour to studying the results of the above method, and to him also is due the credit of introducing the orthoptic treatment by stereoscopic exercises to a recognised place in ophthalmology.

Orthoptic Treatment.—The first essential for its successful employment is a consciousness of diplopia, and if this is not already present, it must be created if possible.

It may be elicited in some cases by placing a prism base downwards before the deviating eye and using a candle-flame in a darkened room as a test object. A red glass before one eye heightens the contrast between the images. Javal recommends that a large sheet of cardboard should be held vertically between the two eyes, one edge resting against the nose and brow, and that the flame be held at about two metres distance. If double vision is not at once appreciated, alternate exposure of the eyes should be employed to rouse it. The experiment must be repeated frequently and daily until diplopia is established without any artificial assistance. The next stage requires the use of a stereoscope, with + 6D sph. lenses in place of the usual prisms. The patient must also wear his proper correcting spectacles.

To a normal pair of eyes a pair of stereoscopic pictures seen through the lenses at their focal distances will appear single, and this without any accommodative or convergent effort. To a squinter they will appear double (if conscious of his diplopia). By gradually diminishing the distance between the pictures the patient should at length be able to fuse them into a coincident impression. The distance must now be daily increased and the exercise continued until fusion is secured in the normal position. Only simple geometrical figures or elementary pictures in which each unit of the pair is the complement of the other unit should be employed.

Worth has introduced an ingenious stereoscope ("Amblyoscope") consisting of two tubes (each containing a lens and mirror), so shaped and hinged as to enable them to be adapted to the angular deviation of the eyes, and each carrying a transparent test object at the focal plane of the lens, both lens and test object complying with the conditions mentioned above.

Each tube can be separately illuminated. By increasing the brilliance of the illumination of the image which is falling on the defective eye and weakening, if need be, that of the better eye, the sense of diplopia is aroused. The pictures being dissimilar can be readily described by the patient, and being gradually brought together their combination presents some new feature for description. The exercise consists in a gradual training to fuse the images. This method seems specially useful for young children. Priestley Smith's "heteroscope" deserves mention as another recent device for orthoptic exercises.

Controlled or Bar-Reading.—A further means of encouraging binocular reading, advocated by Javal, consists in holding an opaque rod such as a pencil vertically between the eyes and the printed page at such distance that the letters which are shut off by the rod from one eye are visible to the other, and reading with both eyes open can be carried on uninterruptedly, provided each can take its share.

It is, however, only the slighter cases of strabismus, or those which have been rendered slight by operation, which are capable of cure by orthoptic exercises, and it must be confessed that the results are often very disappointing, probably because the treatment is not applied early enough.

Operative Treatment.—This should never be undertaken until some or all of the above methods have been exhausted, nor should it be recommended in young children, whose powers of innervation are necessarily immature, and whose visual powers are undeveloped.

In convergent strabismus of 15° to 20° the simplest surgical remedy is the division of the internal rectus of the squinting eye. The average effect of a single tenotomy is found to be a reduction of convergence by about 15°. If the primary deviation amount to, say, 35° to 40°, the effect may be divided between the two eyes by tenotomy of each internal rectus.

Great care must be exercised, especially in young persons, not to produce too full an effect; indeed it is a safe rule to leave a few degrees of convergence uncorrected by operation, for as life advances the convergence spontaneously lessens and may give place to divergence if the internal recti have been weakened too much. Many surgeons prefer to advance the insertion of the external rectus muscle instead of tenotomising the internal rectus, claiming that it gives a better range of mobility, as well as a better cosmetic result. For slight cases, a simple tenotomy is more expeditious, requires less after-treatment, and is practically satisfactory to most people.

Where the squint exceeds 35°, and in all cases where the outward movements of the eyes are feeble, advancement of the external rectus, combined with tenotomy of the internal rectus, is demanded. In the worst cases the combined operation may be necessary for each eye before the deviation can be satisfactorily remedied.

In divergent strabismus, simple tenotomy of the external rectus is seldom of much benefit, and except in the slighter degrees of insufficiency of convergence, the advancement of the internal rectus is to be preferred, or must be superadded.

For an accouut of the usual methods of performing these operations, the reader should consult any text-book of ophthalmic surgery.

Vertical deviations of slight degree are usually relieved by the use of prisms in the correcting glasses, but if causing annoyance or disfigurement, operative benefit may be obtained by tenotomy of the superior rectus of the upturned eye or the inferior rectus of the downturned eye or both.

Strabometry. *See* Strabismus (*Measurement of Degree*).

Strain. *See* Heart, Myocardium and Endocardium (*General Pathology, Etiology*).

Strait.—The narrow part, *e.g.* the upper strait (or brim) of the pelvis.

Strait-waistcoat. *See* Insanity, General Treatment of (*Mechanical Restraint*).

Stramonium. *See also* Analgesics; Pharmacology; etc.—The dried seeds of *Datura stramonium*, containing an alkaloid, *daturine*, identical with atropine. *Preparation* — Extractum Stramonii. *Dose*—$\frac{1}{4}$-1 gr. The dried leaves of the same plant contain the same principles, but in less constant proportion. *Preparation.* — Tinctura Stramonii. *Dose* — 5-15 m.

The action of stramonium is similar to that of belladonna; but it appears to be less suitable for all the purposes for which the latter is employed, with the exception of relaxation of the bronchial tubes. It is therefore preferred for cases of asthma. It may be administered internally, smoked as cigarettes, or the fumes of a burning powder containing stramonium may be inhaled. Such powders usually contain stramonium, cannabis indica, lobelia, and nitre. The proprietary asthma "cures" are of similar composition.

Strangulation. *See* Asphyxia (*Causes*); Hernia (*Conditions of Strangulation*); Medicine, Forensic (*Death from Asphyxia*); Ovaries, Diseases of (*Cysts, Twisting of Pedicle, Diagnosis*); Peritoneum, Acute Peritonitis, General (*Etiology*); Scrotum and Testicle, Diseases of (*Ectopia Testis*).

Strangury. — Micturition accomplished with pain, and generally drop by drop. *See* Colic (*Diagnosis*); Micturition (*Pain*).

St. Raphael. *See* THERAPEUTICS, HEALTH RESORTS (*Riviera*).

Strassburg's Test.—The sugar and sulphuric acid test for bile acids in the urine; if violet colour, indicates the presence of the acids.

Strathpeffer. *See* BALNEOLOGY (*Great Britain*); MINERAL WATERS (*Chalybeate and Sulphated*); THERAPEUTICS, HEALTH RESORTS (*Scotch*).

Stratum.—A layer, lamina, or membrane; *e.g.* the various *strata* of the skin (*stratum corneum, granulosum, lucidum*, and *Malpighii*), the *stratum bacillorum* of the retina, and the *stratum zonale* of the corpora quadrigemina. *See* SKIN, ANATOMY AND PHYSIOLOGY OF.

Strauss' Reaction. *See* GLANDERS (*Diagnosis*).

Strauss' Sign.—A means of determining the central or the peripheral origin of facial paralysis: in the central form, the injection of *pilocarpine* causes no difference in the amount of perspiration on the two sides, whereas in the peripheral form the secretion on the affected side is retarded.

Strawberry Tongue. *See* SCARLET FEVER (*Symptomatology, Tongue*).

Streak.—A line, stripe, or furrow, *e.g.* the *primitive streak* in Embryology.

Streams.—Rules for the prevention of the pollution of streams and rivers by solid matters, sewage, trade and mining effluents, are stated in the Rivers Pollution Prevention Acts of 1876 and 1893, and in the Public Health (Scotland) Act of 1897.

Streets.—The rules for the making of new streets and for the scavenging and cleansing of them are embodied in various Acts of Parliament, including the Public Health Act of 1875, the Public Health Act Amendment Act of 1890, the Towns Improvement Clauses Act of 1847, the Public Health (London) Act of 1891, and the Public Health (Scotland) Act of 1897, etc.

Strepto-.—In compound words *strepto-* (Gr. στρεπτός, twisted or pliant) means twisted or chain-like, *e.g. streptobacilli* and *streptobacteria* (bacilli or bacteria in chains).

Streptococci.—Cocci linked together in chains; *e.g.* the *streptococcus diphtheriæ*, the *streptococcus erysipelatis*, the *streptococcus pyogenes*, etc. *See* BONE, DISEASES OF (*Osteomyelitis due to Pyogenic Infection*); DIPHTHERIA (*Morbid Anatomy and Pathology*); DISINFECTION (*Ways of Egress of Infection*); EAR, ACUTE INFLAMMATION OF THE MIDDLE (*Causes*); EAR, MIDDLE, CHRONIC SUPPURATION (*Bacteriology*); ERYSIPELAS (*Etiology*); HEART, MYOCARDIUM AND ENDOCARDIUM (*Malignant Endocarditis*); IMMUNITY (*Streptococcal Infections*); INTESTINES, DISEASES OF (*Bacteria in the Intestinal Tract*); JOINTS, DISEASES OF (*Pyogenic*); LUNG, TUBERCULOSIS OF (*Pyrexia, Cause of*); MENINGES OF THE CEREBRUM (*Purulent Meningitis, Etiology*); NOSE, EXAMINATION OF THE (*Character of Secretion*); NOSE, ACCESSORY SINUSES, INFLAMMATION OF (*Etiology, Bacteriology*); PERITONEUM, PERITONITIS (*Bacteriology*); PHARYNX, ACUTE PHARYNGITIS (*Hospital Sore Throat*); PLEURA, DISEASES OF (*Pathology, Bacteriology*); PNEUMONIA, BACTERIOLOGY OF; RHEUMATISM, ACUTE (*Etiology, Exciting Cause*); SCARLET FEVER (*Etiology, Bacteriology*).

Streptomycosis. *See* SUPPURATION (*Etiology*).

Streptopyosis. *See* SUPPURATION (*Etiology*).

Streptosomus.—A teratological type in which there is abdomino-thoracic eventration with twisting of the spine so that the limbs are displaced from right to left.

Streptothrices.—Micro-organisms intermediate in position between the bacteria and the moulds. *See* ACTINOMYCOSIS; MICRO-ORGANISMS (*Streptothrices*); MYCETOMA (*Pathology*).

Stress. *See* TABES DORSALIS (*Etiology, Stress*).

Stretchers. *See* FIRST AID (*Means of Transport*).

Stretching.—The operation of forcible lengthening of a part or of separation of that part (*e.g.* the sciatic nerve) from adhesions, *e.g.* in cases of neuralgia.

Stria.—A streak, pigmented stripe, or linear ridge or marking; *e.g.* the *striæ acusticæ* (transverse white lines on the floor of the fourth ventricle of the brain), *striæ gravidarum* (the purple and white streaks seen in the skin of the abdominal walls during and after pregnancy), and the *striæ musculares* (the transverse markings on striped muscular fibres). *See* POST-MORTEM METHODS (*External Examination, Striæ Gravidarum*); PREGNANCY, PHYSIOLOGY (*Local Changes, Abdominal Wall*); SCLERODERMIA (*Circumscribed, Morphœa*).

Stricture. *See* COLON, DISEASES OF (*Malignant, Stricture*); EAR, EXTERNAL, DISEASES OF (*Malformations*); GASTRO-INTESTINAL DISORDERS OF INFANCY (*Congenital Stricture of Pylorus*); LARYNX, AFFECTIONS OF THE CARTILAGES (*Stenosis*); ŒSOPHAGUS (*Stricture from Malignant Growths*); RECTUM, DISEASES OF THE (*Stricture*); STOMACH, SURGICAL (*Cicatricial*

Stenosis of Pylorus); URETHRA, DISEASES OF (*Stricture*).

Stridor.—A harsh form of respiration, due to obstruction at some part of the respiratory tract (in the larynx, trachea, or bronchi). *See* LARYNX, CONGENITAL LARYNGEAL STRIDOR; LARYNX, LARYNGISMUS STRIDULUS; LYMPHATIC SYSTEM, PHYSIOLOGY AND PATHOLOGY (*Status Lymphaticus*); MEASLES (*Symptoms, Aberrant Laryngeal Stridor*); STATUS LYMPHATICUS; etc.

Stridulous.—Making a harsh, creaking, or rasping sound, *e.g.* in *laryngismus stridulus* (*see* LARYNX, LARYNGISMUS STRIDULUS).

Strigil.—A flesh-brush (Lat. *strigilis*, a scraper). *See* BALNEOLOGY (*Historical*).

Stripe. *See* STREAK; STRIA; etc.

Strobila.—An adult tapeworm (Lat. *strobilus*, a pine cone). *See* PARASITES (*Cestodes, Tapeworms*).

Stroma.—The sustentacular portion of an organ, usually consisting of fibrous connective tissue.

Stromuhr.—An instrument for determining the velocity of the flow of blood in arteries or veins. *See* PHYSIOLOGY, CIRCULATION (*Flow of Blood, Velocity*).

Strongylus. *See* PARASITES (*Nematodes, Strongylidæ*).

Strontium and its Salts.—This element and its salts are not officinal in the B.P., but the bromide has been used in epilepsy and the lactate in nephritis.

Strophanthus.—The dried ripe seeds of *Strophanthus kombé*, an African plant from which the natives make arrow poison. The seeds are oval in shape, fawn coloured, and covered with silky hairs. The chief constituent is *strophanthin*, a white soluble glucoside, which can be broken up by acids into glucose and strophanthidin. *Strophanthin* may be given hypodermically in doses of from $\frac{1}{300}$-$\frac{1}{100}$ gr. It is irritating at the seat of injection. *Preparations*—1. Extractum Strophanthi. *Dose*—$\frac{1}{4}$-1 gr. 2. Tinctura Strophanthi. *Dose*—5-15 m. This is half the strength of the tincture in the B.P. 1885.

We owe our knowledge of the action and uses of strophanthus largely to the work of Sir Thomas R. Fraser; and in prescribing the drug the tincture made according to his directions is always to be preferred to the pharmacopœial tincture. Its action on the circulatory system is similar to that of digitalis, with the important exception that it only slightly constricts the peripheral vessels. Increased blood-pressure and diuresis following its administration are therefore due to the action on the heart itself. In further contrast to digitalis, it is not cumulative in its effect. In large doses it may cause vomiting and diarrhœa, but in moderate quantities it probably disturbs primary digestion less than does digitalis. In cases of cardiac disease it regulates and strengthens the heart's action, diminishes palpitation and dyspnœa, and, when venous stasis has been present, produces diuresis. It is usually stated that in prescribing a cardiac tonic digitalis is the drug of choice and is to be given first, and that if it fails or proves unsuitable in any way strophanthus is to be substituted. Although it must be admitted that in a considerable number of cases strophanthus may only come into use for such reasons, and although it cannot be claimed that as a cardiac tonic for general purposes strophanthus is the equal of digitalis, still a consideration of its pharmacological action and a study of its clinical effects will in most instances afford more rational and scientific indications for its employment. Like digitalis, it gives the best results in cases of cardiac valvular disease in which the mitral valve is affected, and it is specially useful when there is present a heightened arterial tension, any increase of which would embarrass the heart's action and counteract the beneficial effects. Again, the action of strophanthus is much more immediate than that of digitalis, which may be taken for several days without any marked effect resulting; and it may therefore be of great service when it is expedient to get the patient rapidly under the influence of a cardiac tonic. Experience has shown that it is to be preferred in cardiac disease of children under twelve. In cases of heart strain with slight dilatation it is of great value in restoring the normal cardiac action. In fatty degeneration of the heart it often does good by increasing the activity of the muscular contraction and improving the nutrition of the heart wall. Lastly, it is probably the only remedy to be relied on in threatened heart failure in lobar pneumonia, and in the treatment of these cases it must be given in large and frequently repeated doses as recommended by Greenfield. It is also to be regarded as the sheet-anchor in those grave cases of cardiac debility complicating influenzal pneumonias.

Stropho-.—In compound words *stropho-* (Gr. στρόφος, a twisted band or belt) means displaced or twisted; e.g. *strophocephaly*, a teratological type in which there is marked displacement of various parts of the head and face, such as otocephaly.

Strophulus.—A papular skin eruption or form of miliaria; red gum. *See* MILIARIA (*Miliaria Rubra*).

Struma.—Scrofula or tuberculosis (in a general sense) or goitre; the last-named meaning is rather a German usage of the term.

Strumiprival.—Having lost the thyroid gland; this has as its result a form of cachexia (*cachexia strumipriva*); thyroprival.

Strümpell's Disease.—Acute primary hæmorrhagic encephalitis.

Strümpell's Paralysis.—The hereditary or family form of spastic spinal paralysis.

Strümpell's Theory. *See* Athetosis (*Pathology, Polio-encephalitis*).

Strychnia and Strychnina. *See* Strychnine.

Strychnine. *See also* Alkaloids; Asphyxia (*Causes*); Heart, Myocardium and Endocardium (*Treatment, Medicinal*); Nux Vomica; Pneumonia, Clinical (*Rational Treatment*); Toxicology (*Strychnine*).—Nux Vomica, the poison-nut, is the dried ripe seeds of *Strychnos nux vomica*, an East Indian tree. It contains two alkaloids, *strychnine* and *brucine*, the former being the more powerful. The *dose* of nux vomica is 1-4 grs. *Preparations*—1. Tinctura Nucis Vomicæ, containing $\frac{1}{4}$ gr. strychnine in 110 m. *Dose*—5-15 m. 2. Extractum Nucis Vomicæ, containing about 5 per cent of strychnine. *Dose*—$\frac{1}{4}$-1 gr. 3. Extractum Nucis Vomicæ Liquidum, containing $1\frac{1}{2}$ gr. strychnine in 110 m. *Dose*—1-3 m.

Strychnine occurs as minute, odourless, elongated prisms of a creamy white colour. It is extremely bitter, and can be tasted in a solution of 1 in 30,000 in water. It is sparingly soluble in water, but much more readily dissolved in alcohol and chloroform. *Dose*—$\frac{1}{60}$-$\frac{1}{15}$ gr. *Preparation*—Syrupus Ferri Phosphatis c. Quinina et Strychnina. Each fl. dr. contains $\frac{1}{32}$ gr. strychnine. *Dose*—$\frac{1}{2}$-1 ʒ.

Strychninæ Hydrochloridum is more commonly used. It is soluble 1 in 35 of water. *Dose*—$\frac{1}{60}$-$\frac{1}{15}$ gr. *Preparation*—Liquor Strychninæ Hydrochloridi. Contains 1 gr. in 110 m. *Dose*—2-8 m. (by mouth); 1-4 m. (hypodermically).

Nux vomica is very largely used, with excellent results, as a bitter stomachic in cases of feeble digestion with an atonic condition of the gastro-intestinal musculature. In chronic constipation it is a valuable addition to other remedies as a stimulant to peristalsis. For this same action it is often of the greatest service in the after-treatment of abdominal operations for the prevention of threatened paralytic bowel distension. It forms an ingredient of most tonic mixtures prescribed for conditions of general depression or ill-health, for the debility following severe illness, and nerve exhaustion following overwork, etc. Much difference of opinion exists as to the indications for the use of strychnine as a cardiac stimulant. It should be remembered that it is in no sense a cardiac tonic, but a powerful circulatory stimulant acting through the nervous system. It is thus invaluable as a whip to a flagging heart in threatened sudden heart-failure in the course of any disease, in profound shock, after severe hæmorrhage, in syncope during chloroform anæsthesia, and in opium poisoning. But its continued employment throughout a long, exhausting illness is usually harmful, and simply overdrives a willing but already partially exhausted heart. For similar reasons over-stimulation by means of strychnine in cases of post-operative shock should be carefully guarded against. In some cases of organic cardiac trouble, however, strychnine appears to have a more beneficial effect than either digitalis or strophanthus. As a respiratory stimulant, also, strychnine must be used with discrimination. In the dyspnœa of severe bronchitis and of phthisis it is often invaluable as a direct stimulant to the respiratory centre, especially when the breathing is becoming feeble and shallow; but in pneumonia, where most often the danger lies in cardiac exhaustion from toxæmia, stimulation of respiration is uncalled for and may be injurious. Strychnine has been employed in a large number of nervous diseases. In progressive muscular atrophy it appears to have done good, and also in lead palsy. In old-standing hemiplegias and infantile paralysis it may be helpful, but it should never be used during the acute stage of such diseases. In post-diphtheritic paralysis it is of great service. It has given excellent results in some cases of nocturnal incontinence. Occasionally chorea minor is benefited by strychnine when other drugs have failed. In amaurosis brought on by alcohol or tobacco it is almost a specific. A combination of strychnine and atropine is recommended to counteract the craving for drink in cases of alcoholism.

St. Sauveur. *See* Balneology (*France, Sulphur Waters*).

Stultitia.—Mental dulness. *See* Mental Deficiency, etc.

Stump. *See* Amputations; Ankle-Joint, Region of, Operations; etc.

Stupe.—A pledget or cloth wrung out of hot water and applied to the skin as a counter-irritant; it may be sprinkled with laudanum or turpentine to increase its effect.

Stupidity. *See* Adolescent Insanity (*Lesser Mental Changes*).

Stupor.—Mental torpor; although used in a somewhat vague fashion, the term stupor is usually given either to acute dementia (*anergic* stupor) or to delusional or melancholic stupor (*melancholia cum stupore*). *See* Adolescent Insanity (*Puberty and Adolescence*); Catalepsy

(*Differential Diagnosis*); Chorea (*Choreic Insanity*); Insanity, its Nature and Symptoms (*Types of Episodic Insanity, Stupor*); Toxicology (*Opium and Morphine*).

Stupor Vigilans. *See* Catalepsy.

Stupration.—Rape (Lat. *stuprum*, defilement). *See* Medicine, Forensic (*Rape*).

Stuttering. *See* Stammering.

St. Vitus's Dance. *See* Chorea (*Synonyms*).

Stye. *See* Eyelids, Affections of (*Hordeolum or Stye*).

Stylo-.—In compound words *stylo-* (Gr. στῦλος, a pillar) means shaped like a pillar or style, or, more particularly, relating to the styloid process of the temporal bone; e.g. *stylo-glossal*, *stylo-hyal*, *stylo-mastoid*, and *stylo-pharyngeus*.

Stymatosis.—Erection of the penis of a violent type (Gr. στῦμα, stiffness); chordee.

Stypticine.—The hydrochlorate of cotarnine; an amorphous yellow powder which acts as a general and local hæmostatic; it may be given internally in doses of $\frac{5}{6}$ of a grain, two or three times a day, or it may be used locally in the form of stypticine gauze (30 per cent) or ointment (with lanoline and vaseline); it has been strongly recommended in the obstetrical and gynæcological hæmorrhages (threatened abortion, bleeding at the menopause, etc.), in bleeding from the nose, bladder, and after tooth-drawing, and in cases of bleeding piles.

Styptics. *See* Astringents; Hæmatemesis (*Treatment*); Pharmacology; etc.

Styptol.—A hæmostatic remedy; it is cotarnine phthalate, and forms a white crystalline powder, soluble in water; it is said to be less irritating than stypticine; like stypticine, it has been strongly recommended in gynæcological hæmorrhages, such as the bleeding from endometritis, fibroids, cancer, polypi, and subinvolution, as well as in puerperal bleeding and that of a threatened abortion; the dose is $\frac{5}{6}$ of a grain from three to five times a day; externally, it has been used in the form of a 1 to 5 per cent solution in superficial inflammations, eczema, etc.; it has the chemical formula of $(C_{12}H_{14}NO_3)_2C_6H_4(CO_2)_2$.

Styracol.—The cinnamate of guaiacol, a white crystalline powder, with the formula $C_6H_4(CH_3O)C_9H_7O_2$; it has been strongly recommended in pulmonary tuberculosis, in intestinal catarrh, in rheumatoid arthritis, and in chronic diarrhœa; it is insoluble in water and in the acid contents of the stomach, but is absorbed from the intestine; it probably owes its effects to both the guaiacol and the cinnamic acid which it contains; the dose is from 8 to 15 grains.

Styrax. *See* Storax.

Styrol.—Cinnamene (C_8H_8) or phenylethylene, a liquid hydrocarbon got from benzene by heating it with calcium hydrate; it has an odour resembling that of benzene.

Styrone.—An antiseptic substance, in thin needles, formed with styrax and balsam of Peru; cinnamic alcohol ($C_9H_{10}O$).

Sub-.—In compound words *sub-* (Lat. *sub*, under, below, or beneath) signifies beneath or less than; in Chemistry *sub-* means the lower of two compounds of any one of the elements, *e.g.* the *subacetate* of lead ($Pb_2O(C_2H_3O_2)_2$) as compared with the acetate ($Pb(C_2H_3O_2)_2$); *subacid* means moderately acid; *subacromial*, below the acromion process; *subaponeurotic*, below an aponeurosis; *subcalcarine*, beneath the calcarine fissure of the brain; *subcrepitant*, indistinctly crepitant; etc.

Subarachnoid Space.—The space lying below the arachnoid membrane, between it and the pia mater; it contains the cerebro-spinal fluid, and it has communications with the ventricles of the brain; it is this space (in the spine) which is tapped in drawing off fluid for diagnostic purposes and in injecting anæsthetic liquids in spinal anæsthetisation. *See* Meninges of the Cerebrum (*Anatomy*); Spine, Surgical Affections (*Lumbar Puncture*, *Spinal Cocainisation*).

Subclavian.—Situated under the clavicle, *e.g.* the subclavian artery, groove, nerve, and vein. *See* Aneurysm (*Situation, Neck*); Arteries, Injuries of (*Wounds of Special Arteries*); Arteries, Ligature of (*Subclavian Artery*); Shoulder, Diseases and Injuries of (*Ligature of Arteries*).

Subconsciousness.—"Subconsciousness is that whole mass of cerebral activity to which the mind does not attend" (G. R. Wilson). *See* Insanity, Nature and Symptoms (*Relation of Mind and Brain, Plurality and Subconsciousness*).

Subculture.—In Bacteriology, a secondary culture made from a previous culture.

Subcutaneous.—Beneath the skin (subdermal) or beneath the cuticle (subcuticular); *e.g.* subcutaneous injections (*see* Transfusion), subcutaneous nævus (*see* Electrolysis, *in Angioma*), and subcutaneous nodules (*see* Rheumatism in Children, Rheumatoid Arthritis).

Subdural Space.—The space below

the dura mater, between it and the arachnoid. *See* MENINGES OF THE CEREBRUM (*Anatomy and Physiology*).

Subfebrile. — Somewhat or slightly febrile. *See* TEMPERATURE (*Fever*).

Subglossitis.—Inflammation of the tissues in the floor of the mouth, under the tongue. *See* TONGUE (*Inflammatory Affections*).

Subglottic. *See* LARYNX, ACUTE AND CHRONIC INFLAMMATIONS (*Chronic Subglottic Laryngitis*); LARYNX, MALIGNANT DISEASES OF (*Symptoms*).

Subinvolution.—Imperfect return of an organ to its normal size after hypertrophy and distension, due to various causes, but especially to chronic inflammation and congestion; the term is most often used in connection with the uterus after labour or abortion. *See* MENSTRUATION AND ITS DISORDERS (*Menorrhagia*); PREGNANCY, DIAGNOSIS (*Differential*); UTERUS, INFLAMMATIONS OF (*Subinvolution*).

Subjective. — Belonging to the individual (*e.g.* a patient), especially *symptoms* as opposed to *signs* of disease.

Sublimate, Corrosive. *See* MERCURY (*Hydrargyri Perchloridum*).

Sublimation. — The conversion of a volatile solid substance into vapour, and its condensation.

Sublingual.—Beneath the tongue; *e.g.* the sublingual salivary glands, sublingual cysts, sublingual artery, etc. *See* SALIVARY GLANDS, DISORDERS OF (*Anatomy*); TONGUE (*Cysts*).

Subluxation. — Incomplete or partial dislocation. *See* MOUTH, INJURIES AND DISEASES OF THE JAW (*Chronic Arthritis of Temporo-Maxillary Joint*).

Submammary.—Beneath the breast or mamma; *e.g.* a submammary abscess, a submammary injection, etc. *See* MAMMARY GLAND.

Submarginal. — Situated near the margin or periphery.

Submaxillary.—Situated beneath the lower jaw or inferior maxilla; *e.g.* the submaxillary salivary gland, submaxillary artery and vein, submaxillary ganglion, etc. *See* SALIVARY GLANDS, DISORDERS OF (*Anatomy*).

Subminimal.—Less than minimal, *e.g.* a subminimal stimulus (one not sufficient to cause an obvious effect).

Submucous. — Situated beneath the mucous membrane of an organ; *e.g.* a submucous fibroid of the uterus, the submucous coat or layer (*submucosa*), submucous cystitis (inflammation of the vesical submucosa), submucous operations on the nasal septum, etc. *See* UTERUS, NON-MALIGNANT TUMOURS OF (*Fibroids*).

Subnasal.—In a special sense this term means at the base of the nasal spine; more generally it signifies below the nose.

Suboccipito-Bregmatic. — Belonging to the lower part of the occiput and to the bregma (anterior fontanelle), *e.g.* the suboccipito-bregmatic diameter of the fœtal head (S.O.B.). *See* LABOUR, PHYSIOLOGY OF (*Passenger, Diameters of Head*).

Subpericranial.—Beneath the pericranium, *e.g.* a subpericranial hæmorrhage.

Subperitoneal. — Beneath the peritoneum covering an organ, *e.g.* a subperitoneal fibroid of the uterus. *See* UTERUS, NON-MALIGNANT TUMOURS OF (*Fibroids*).

Subphrenic.—Beneath the diaphragm; *e.g.* a subphrenic abscess, subphrenic hydatids, etc. *See* HYDATID DISEASE (*Diagnosis*); LIVER (*Tropical Abscess, Diagnosis*); PANCREAS, DISEASES OF (*Pancreatitis, Diagnosis*); PERITONEUM, ACUTE PERITONITIS, GENERAL (*Subphrenic Abscess*); STOMACH AND DUODENUM, DISEASES OF (*Ulcer of Stomach, Perforation and Results*).

Subpubic.—Situated below the symphysis pubis; *e.g.* the *subpubic arch, subpubic ligament, subpubic hernia*, etc.

Subscapular. — Beneath, or rather ventral to, the scapula, *e.g.* the *subscapular artery, nerve*, and *region*.

Subseptate.—Divided partially into cavities; *e.g.*, a subseptate uterus is one divided into two cavities by an incomplete septum.

Subserous. — Subperitoneal or subpleural, or, generally, beneath a serous membrane; also, somewhat serous or watery.

Subsoil.—The stratum of earth immediately below the surface layer; water in this part is termed "subsoil or ground water," and is bounded above by a permeable and below by an impermeable layer. *See* DIPHTHERIA (*Etiology, Level of Ground Water*).

Subspinous.—Beneath the spine, *e.g.* of the scapula, of a vertebra, etc. *See* SHOULDER, DISEASES AND INJURIES OF (*Dislocations, Subspinous*).

Substance or Substantia. *See* PHYSIOLOGY, TISSUES (*Cartilage, Bone*, etc.).

Substitution.—The replacement of one thing by another; in Chemistry, the replacement of "one or more elements or radicles in a compound by others"; in Prescribing, the

replacement of one drug or form of drug by another in the preparing of a medicine.

Subsultus.—A jerky movement, *e.g.* of muscles and tendons (*subsultus tendinum*), such as occurs in the late stage of the grave form of typhoid fever.

Subtotal.—Incomplete; especially used in relation to incomplete or partial abdominal hysterectomy as opposed to complete hysterectomy or panhysterectomy. *See* Uterus, Non-malignant Tumours of (*Fibroids, Treatment, Hysterectomy*).

Succedaneum.—Supplying the place of another, a substitute (Lat. *succedaneus*, that which follows after); *e.g.* the *caput succedaneum* or œdematous swelling on the head of the fœtus which forms during labour as a result of the pressure to which the head is subjected, and which gives the sensation to the examining finger of another head.

Succenturiate.—Accessory (Lat. *succenturio*, I receive as a recruit, as a substitute), *e.g.* a succenturiate lobe of the placenta.

Succi.—The expressed juices of plants, with alcohol added for preserving purposes; there are six officinal succi, viz. the Succus Belladonnæ, S. Hyoscyami, S. Conii, S. Scoparii, S. Taraxaci, and S. Limonis; the dose of the Succus Belladonnæ is small (5 to 15 m.), that of Succus Hyoscyami is 30 to 60 m., while that of the others is 1 to 2 dr. and that of Succus Limonis is ½ to 4 fl. oz. In the singular, *succus* is also used to designate some of the secretions of the body; *e.g.* the *succus entericus, succus pancreaticus.*

Succi's Fast. *See* Physiology, General Metabolism (*During Fasting*).

Succursal Asylum.—A provincial asylum "appropriated to one particular class of lunatics, namely the insane poor who are incurable and tranquil" (Hack Tuke); it is derived from Lat. *succursalis*, subsidiary.

Succus. *See* Succi.

Succussion.—A method of physical diagnosis of very ancient origin, consisting in the shaking of the thorax to produce splashing sounds due to the presence of free fluid in the thorax (*e.g.* in hydropneumothorax) or in the stomach (dilatation of the stomach); clapotage (Fr.). *See* Pleura, Diseases of (*Pneumothorax, Clinical History*).

Sucking Pads.—Localised collections of fat in the cheeks of the infant which prevent the drawing in of the tissues of the cheeks into the mouth in sucking.

Suckling. *See* Infant Feeding (*Nursing*); Puerperium, Physiology (*Lactation*).

Sudamina.—A vesicular eruption due to disturbance of function of the sweat glands (Lat. *sudor*, sweat). *See* Miliaria (*Miliaria Crystallina*); Skin, Diseases of Sweat and Sebaceous Glands (*Sweat Glands, Sudamina*).

Sudatorium.—A hot-air bath. *See* Balneology.

Sudden Death. *See* Angina Pectoris (*Prognosis*); Heart, Myocardium and Endocardium (*Effects of Cardiac Disease*); Pleura, Diseases of (*Acute Pleurisy, Prognosis*); Status Lymphaticus; Thymus Gland; Typhoid Fever (*Prognosis*).

Sudorifics.—Drugs or methods of treatment inducing free perspiration; diaphoretics; *e.g.* pilocarpine, ipecacuanha, camphor, warmth, etc. *See* Pharmacology.

Sudoriparous.—Sweat-producing, *e.g.* the sudoriparous glands of the skin. *See* Skin, Anatomy and Physiology.

Suet. *See* Sevum Præparatum.

Suffocatio Hysterica.—The globus hystericus. *See* Hysteria.

Suffocation. *See* Asphyxia; Heart, Myocardium and Endocardium (*General Pathology, Morbid Processes*); Medicine, Forensic (*Death from Asphyxia, Various*).

Sugar. *See* Beriberi (*Nomenclature, Sugar-Works Sickness*); Diabetes Mellitus (*Sugar in Blood, Test*); Diet (*Food Constituents, Non-nitrogenous*); Infant Feeding (*Cow's Milk, Addition of Sugar*); Glycosuria; Liver, Physiology of (*Functions, Carbohydrates*); Meningitis, Tuberculous (*Symptoms, Sugar in Urine*); Milk; Pancreas, Physiology of (*Excretion of Sugar*); Pregnancy, Physiology (*Changes in Urine*); Saccharum Lactis; Saccharum Purificatum.

Suggestion. *See* Hypnotism.

Suggilation or Sugilation.—A bruise or ecchymosis of a livid, black and blue colour (Lat. *sugillo*, I beat black and blue).

Suicidal. *See* Suicide. *See also* Hypnotism (*in Insanity*); Insanity, Its Nature and Symptoms (*Suicidal Melancholia*).

Suicide.

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See also Lunacy (*Increase of Insanity, Suicides*); Malingering (*Suicidal Attempts*);

MEDICINE, FORENSIC (*Wounds, Accident, Suicide, or Murder*).

THE extent to which suicide prevails in any country will largely depend on the social organisation and the ethical and religious opinions of the people. From the medical point of view, however, the most important question is its relation to soundness or unsoundness of mind. In every country it is resorted to both by the insane and by persons who are sane, as the word is usually understood. Attempts have been made to estimate the proportion which persons recognised as insane contribute to the total number. Wynn Westcott, deputy coroner for Middlesex, estimates it as 20 per cent, and Professor Kraepelin of Heidelberg estimates it as 30 per cent. It is certain, however, that a large proportion of the reputedly sane persons who commit suicide are not, strictly speaking, of sound mind. The only persons with really sound mental organisation who commit suicide are those who do so by deliberate and reasoned choice, preferring death to some evil, such as dishonour, which they consider greater than death. In the great majority of cases where no pronounced insanity is recognisable, suicide is committed by persons burdened with the neuropathic inheritance, and having more or less of the mental defects and the imperfect nervous organisation of the degenerate. These are the persons who yield to such causes as disappointed hopes, disappointed affection, feelings of shame, anger, jealousy, injured vanity, and also to the influence of suggestion. In these persons the mental organisation is often in a state of such unstable equilibrium that very slight causes are sufficient to produce a morbid impulse. Examples of the ease with which they yield to the suggestion of suicide are furnished by the succession of imitative acts which have followed certain suicides of startling and appalling character, such as those committed by leaping from well-known heights like the Monument in London, the Suspension Bridge at Clifton, the Dean Bridge at Edinburgh, and the Campanile of Giotto at Florence. A singular example occurred in the Hôtel des Invalides at Paris, when fifteen of the inmates hanged themselves in the course of a fortnight from a hook in a dark lobby of the Hôtel. On the removal of the hook the hideous sequence came to an end. Another remarkable instance occurred at the camp near Boulogne in 1805, when several soldiers successively blew out their brains in the same sentry-box. The fashion did not cease until the sentry-box was burnt. Closely related to the effect of suggestion is that of opportunity —that is, the existence of facilities for committing suicide. The absence of such facilities may prevent a passing impulse to suicide from being carried into effect; while the handling of lethal weapons or poisonous substances may both suggest such an impulse, and present the means of giving effect to it. The practical importance of recognising such considerations is illustrated by the statement of Mr. W. H. Millar of the Army Medical Department: "In the eight years," he says, "preceding the order in the year 1869, which took away ball cartridges from the soldiers, the suicides were 122, whereas in the eight years following that order they fell to 63."

It is in cases of one or other of the forms of melancholia that the insane most frequently commit suicide; but there are few of the clinical groups into which insanity is divided in which states of depression leading to suicide may not occur. The suicidal tendency is often strongest in the early stages of melancholia and in the states of depression which occur at the commencement of the insanities of advanced life. Not infrequently an attempt at suicide is the first recognisable indication of an attack of insanity. Among the insane the emotional factor is much more powerful in producing suicide than the intellectual. In some cases, often in the most suicidal, there is little appreciable intellectual disorder. There is depression unaccompanied by any definite delusion. There is a loss of interest in the outer world, the consciousness, which becomes almost entirely subjective, is shrouded in inexplicable gloom, and the dejection is increased by the inability to account for it. When delusions are formed they take their colour from the emotional atmosphere in which they are developed; and such delusions, as self-accusations, are often the result of efforts to find an intellectual basis for the previously existing depression. Suicide among the degenerate may also be the result of definite suicidal obsession; a beleaguering, imperative idea impelling to self-destruction, often seizing hold of the mind suddenly, and therefore specially dangerous. These obsessions do not become part of the personality, and the patient often strives hard to resist them. In both acute and chronic alcoholism the suicidal tendency is frequent, especially when it is implanted on the neuropathic constitution. It is useful to take note also that suicidal acts have been known to occur in automatic conditions such as are associated with epileptic seizures.

It is often said that the impulse to suicide is strongly hereditary, apart from the mere transmission of a mental organisation specially liable to sombre obsessions. The belief is founded chiefly on remarkable instances that have occurred of the descendants of suicidal ancestors killing themselves, often at the same age and in the same manner as their ancestors did. It is difficult, however, in such cases to determine how much should be attributed to heredity, and how much to the influence of suggestion. The prevalence of such a belief tends to bring about its own realisation, as the following case given by Falret shows. A young woman who

had been taught that suicide was strongly hereditary was informed that an uncle on her father's side had killed himself. She was greatly depressed by this, and had fears as to her own future. While she was under this depression her father himself committed suicide, and this so affected her mind that she attempted suicide. But her mother, being then seriously alarmed for her child, confided to her that her reputed father was not really her father, and that therefore her ideas about the fatal heredity were baseless. From that time the depression gradually abated, and the girl regained complete soundness of mind.

Statistics of Different Countries.—There is no branch of vital statistics in which it is necessary to be more guarded before drawing inferences than the statistics of suicide. In no country are the official figures altogether accurate or complete, and the principles upon which they are collected differ so greatly that comparisons between the statistics of different countries must be made with some reserve. Subject to this caution, however, the following table may be accepted as based on the most trustworthy data that are available :—

Numbers of Suicides by Different Methods in European Countries

(a) *Rates per Million of Population*

Methods.	England and Wales. 1878-88.	Scotland. 1877-94.	Ireland. 1881-90.	France. 1878-87.	Italy. 1873-88.	Switzerland. 1878-85.	Prussia. 1878-88.	Saxony. 1878-88.	Sweden. 1878-88.	Denmark. 1875-85.
Hanging	24	17	6	82	7	102	119	229	52	199
Drowning	16	16	5	52	12	58	36	70	19	35
Gunshot	5	3	3	23	12	44	21	32	11	9
Cut, Stab	13	10	5	5	2	12	6	8	8	4
Poison	9	6	1	4	3	8	7	10	8	5
Otherwise	6	4	2	24	9	10	6	9	1	2
Total	74	55	23	191	46	234	194	358	99	255

(b) *Numbers per Cent of Total Numbers*

Hanging	33	29	28	43	16	44	61	64	52	78
Drowning	22	28	20	27	26	25	19	20	19	14
Gunshot	7	6	15	12	26	19	11	9	11	3
Cut, Stab	18	19	23	3	5	5	3	2	8	2
Poison	13	10	6	2	7	3	4	3	8	2
Otherwise	9	8	8	13	20	4	3	2	1	1
Total	100	100	100	100	100	100	100	100	100	100

It will be seen that the table represents the extent to which suicide occurs as very different in different countries; and it is undoubtedly true that great differences exist. The table also shows that in most countries suicide by five methods—hanging, drowning, gunshot, cutting or stabbing, and poison—includes more than 90 per cent of the whole number of cases. Of all the methods, suicide by hanging may be accepted as yielding the most trustworthy figures, such deaths being seldom either concealed or attributed to any cause except suicide. The first section of the table gives the average annual rates per million of population, and this is the most instructive section. The second section shows the percentages for each method calculated on the total number of suicides. This is given chiefly because it presents the statistics in the way most frequently adopted by writers on the subject, not only in regard to the methods of suicide, but also in regard to the sexes, ages, occupations, and other details. It leaves out of account, however, the proportion to population, which should never be lost sight of; and its too frequent use has led to important misconceptions. For example, Morselli, founding on such figures, states that the number of suicides by cutting and stabbing is greater in Italy than in France, though a glance at the rates per million of population shows that such suicides occur more than twice as often in France.

Sex and Age.—Men commit suicide more frequently than women, except at the period of adolescence, when the frequency is about equal. Between the ages of 20 and 35 there are in England and Scotland an average of about 2 males to 1 female, between 35 and 65 about 3 males to 1 female, and over 65 about 4 males to 1 female. Both male and female rates rise as age advances, and reach their maximum in most countries between the ages of 45 and 65, the male rates in England and Scotland being then between 250 and 300, and the female rates between 80 and 90. In some countries, such as England and Scotland, the male suicides exceed the female in the proportion of less than 3 to 1; but in other countries it is more than 4 to 1. Two illustrations may be given here of the errors arising from using percentages on the total number of suicides. Legoyt, founding on a statement showing that 27 per cent of the suicides are committed by women, says that it is in England "que les femmes se tuent le plus," though the number of suicides by women per million of the female population in England is only 36; and the corresponding rates are for Prussia 70, for Denmark 110, and for Saxony 130. In the same way, Morselli says that the Spanish women "commit more suicide than any other Europeans," though the figures on which he bases the statement give only 10 female suicides per million of the female population.

Occupation.—Dr. Ogle has given, in a paper on suicide in England and Wales, the most useful statistics that we possess bearing on the relation between suicide and occupation. He avoided many of the complications which tend to obscure the issue, by restricting his investigation to males, and to those only between twenty-five and sixty-five years of age, when the influence of occupation is most strongly felt. The inquiry covered six years, 1878-83. The results showed that, as a general rule, the more an occupation involves hard physical labour the lower is its

suicide rate. Exceptions to this rule are the occupations presenting inducements to intemperance, such as inn-keepers and publicans, which have very high rates. Of the liberal professions the clergy alone have a low rate. The rate for soldiers is much higher than any other.

Season of the Year.—The constancy of the seasonal curve for suicide is very remarkable. In all countries where records have been kept the suicide rate is lower in winter than in summer. In the northern hemisphere suicide is everywhere least frequent in the months of November and December, and the rate gradually rises from that time forward to May and June. After June it falls again steadily to November. In the southern hemisphere the curve is reversed, being lowest in May and June, and highest in November and December. The limits of the present article do not permit of a discussion of the causes of this seasonal distribution; but it may be noted that the course of the curve is not due to the influence of any one mode of suicide. The curve for hanging is the same as the curve for drowning.

The Alleged Increase of Suicide.—It is impossible within the limits of the present article to discuss this question satisfactorily. It may be stated, however, that the figures on which the allegation of an almost universal increase is based are not entirely trustworthy. The writer has discussed the question elsewhere as regards England and Scotland (*Proceedings of the Royal Society of Edinburgh*). Two facts may, however, be mentioned, showing that in these countries at least the allegation is not to be accepted without question. One is that in both England and Scotland the suicides by hanging, which give the most trustworthy figures, show no increase during the thirty years 1865-94. The other is that *deaths from wounding* (gunshot, cutting, and stabbing) show no increase during the same period, though there has been an increase in the number of *such deaths attributed to suicide*, the increase in the number attributed to suicide being almost exactly counterbalanced by the decrease in the number attributed to accident. In order to avoid misconception, it is perhaps desirable to say that a detailed examination of the official figures throws no doubt on the view that the amount of suicide varies according to locality. In Scotland, for instance, the eastern counties show much higher suicide rates than the western counties, and this preponderance persists over a series of years. It does not seem possible to attribute this altogether to more careful registration in the eastern counties, though that may partly account for it; because the predominance shows itself most steadily in the rate for suicide by hanging, which is the rate least dependent on careful registration. In the eastern counties of Forfar and Kincardine, where the rates were highest, the rate for hanging was an annual average of 26 per million for the years 1877 to 1885, and again 26 per million for the years 1886 to 1894; and in Lanark and the other western counties south of the Firth of Clyde the corresponding rates were 14 for the years 1877 to 1885, and 13 for the years 1886 to 1894.

Legal Relations.—By the law of England suicide is a felony (*felo de se*). At one time it involved ignominious burial, but this was abolished by a statute in 1823 and an amending statute in 1882. The rubric in the Church of England Book of Common Prayer, which forbids the office for the burial of the dead to be used in the case of a suicide, is, however, still in force. Suicide was also attended with forfeiture of goods and chattels, but this ceased in 1870, when all forfeitures for felony were abolished. In Scotland it still involves the penalty of single escheat except in cases of insanity. In both England and Scotland any person aiding and abetting another in committing suicide is guilty of murder; and if two persons conjointly try to commit suicide, and only one dies, the survivor is technically guilty of murder. An unsuccessful attempt at suicide is in English law a misdemeanour. At present the tendency is to allow all the penal consequences of suicide to fall into disuse. Suicide may come into relation with civil law in connection with marriage, will-making, or life assurance. In regard to the first two, it comes into question only as evidence of insanity for the purpose of setting aside a marriage or a will, and it has not been held in either case to be in itself sufficient evidence for that purpose, even when the suicide occurred within a day or two after a marriage or after making a will. In regard to life assurance, it used to be the custom to insert in the policy the proviso that suicide rendered it void. This proviso is, however, now seldom given effect to. Some offices have abolished the proviso, and others now limit its operation to a fixed period varying from six months to seven years from the date of issue of the policy. In cases where suicide occurs within these periods, or when there is no expressed exemption from forfeiture, offices generally act liberally by making substantial payment, such as the surrender value or the amount of the premiums paid under the policy.

Sulcus.—A depression or fissure between two ridges, folds, or convolutions, especially of the cerebrum, on which there are many sulci, including the sulcus centralis or fissure of Rolando. *See* Brain, Physiology (*Anatomical*); Physiology, Cerebrum (*Discharging Mechanism*).

Sulphates. *See* Sulphuric Acid.

Sulphide.—A compound of sulphur with an element or with a basic radicle; a salt of sulphuretted hydrogen. *See* Sulphur.

Sulphite. *See* Sulphurous Acid.

Sulpho-.—In compound words *sulpho-* means containing sulphur or related to sulphur; e.g. *sulpho-bacteria* (organisms containing sulphur), *sulpho-carbolic acid* (acid produced by action of sulphuric acid on phenol), etc.

Sulphocyanides. *See* Kidney, Surgical Affections of (*Tumours, Diagnosis, Sulphocyanide in Saliva*); Trades, Dangerous (*Lead Poisoning, Symptomatology, Saliva*).

Sulphonal. *See also* Drug Eruptions (*Sulphonal*); Hæmatoporphyrinuria (*Sulphonal Poisoning*); Hypnotics; Toxicology (*Organic Poisons, Sulphonal*). — Dimethyl-methane-diethylsulphone. A symmetrically prepared substance, produced by the oxidation of a mixture of ethyl-mercaptan and acetone. It is soluble 1 in 450 of cold, and 1 in 15 of boiling water. *Dose*—10-30 grs. It is a hypnotic, and does not have any untoward effects if given in moderate doses. On account of its insolubility it does not usually act for two or more hours, and its action may sometimes be undesirably prolonged. It is not so powerful as chloral, but more powerful than paraldehyde. It is very useful in functional nervous insomnia, and in mental disturbance associated with sleeplessness. It is useless when pain is the cause of the absence of sleep. If taken in large doses over long periods it produces general nervous and digestive disturbances, and sometimes also hæmatoporphyrinuria. The establishment of a sulphonal habit is rare, but not unknown. Sulphonal has been used with some success in chorea, and to relieve spasms and cramps of muscles in fractures of the limbs.

Sulphur. *See also* Diet (*Mineral Constituents*); Kidney, Surgical Affections of (*Actinomycosis, Diagnosis*); Mineral Waters (*Sulphated*); Pigments of the Body (*Melanins*); Urine, Pathological Changes in (*Neutral Sulphur*).—Symbol, S. Atomic weight, 31·8. It is official in two forms:—1. Sulphur Sublimatum. Flowers of sulphur. *Dose*—20-60 grs. *Preparations*—(1) Confectio Sulphuris. *Dose*—60-120 grs. (2) Unguentum Sulphuris. It is also contained in Compound Liquorice Powder. 2. Sulphur Præcipitatum. Milk of Sulphur. A soft powder, not gritty like sublimed sulphur. *Dose*—20-60 grs. *Preparation*—Trochisci Sulphuris, 5 grs. in each. Externally, sulphur is a mild vascular stimulant to the skin, and a parasiticide. In scabies it should be applied copiously, after a hot bath and vigorous rubbing with a rough towel, for three nights in succession. Mild sulphur preparations are used for acne and some other skin diseases. Internally, sulphur is an excellent mild laxative, producing a soft, easy evacuation without pain. It is to be recommended for constipation in children, and in adults who suffer from piles or anal fissure. Its usefulness in bronchitis, rheumatism, sciatica, etc., is open to doubt. Many mineral waters owe part of their action to sulphur and sulphides, and sulphur baths have a considerable reputation for eczema and gouty skin troubles.

Potassa Sulphurata, Calx Sulphurata, and Sulphuris Iodidum (from which is prepared an official ointment) have all been used externally in scabies and other skin diseases.

Sulphuretted Hydrogen. *See* Breath (*Character*); Stomach and Duodenum, Diseases of (*General Symptomatology, Flatulence*); Toxicology (*Gaseous Poisons, Sulphuretted Hydrogen*).

Sulphuric Acid. *See also* Œsophagus (*Inflammation, Causes*); Pigments of the Body and Excreta (*Hæmatin in Urine*); Toxicology (*Inorganic Poisons, Mineral Acids*). — H_2SO_4. A heavy, colourless liquid of an oily consistence, known as vitriol. It is a powerful irritant and escharotic, dehydrating and carbonising the tissues. *Preparations*— Acidum Sulphuricum Dilutum. *Dose*—5-20 m. It is contained in Infusum Rosæ Acidum. 2. Acidum Sulphuricum Aromaticum. "Elixir of Vitriol." *Dose*—5-20 m. It is contained in Infusum Cinchonæ Acidum. Externally, strong sulphuric acid may be used as a caustic for sores, warts, etc.; but other substances are generally prepared for such purposes. Internally, in addition to possessing the actions common to the dilute mineral acids, it is of great service in serous diarrhœa and in cholera, especially if combined with a vegetable astringent. Sulphuric acid is also used in lead poisoning, and lemonade containing sulphuric acid may be consumed by those exposed to poisoning by lead, the object being the formation of the insoluble lead sulphate. In combination with belladonna, it has been found of value in the night-sweats of phthisis.

Sulphuric Ether. *See also* Anæsthesia and Anæsthetics.—Ether is prepared from ethylic alcohol by interaction with sulphuric acid. It is a colourless, volatile, inflammable liquid with a characteristic odour. *Dose*—10-30 m. (repeated); 40-60 m. (single dose). *Preparations*—1. Æther Purificatus. The ethylic alcohol is removed by washing. 2. Spiritus Ætheris. *Dose*—20-90 m. 3. Spiritus Ætheris Compositus. Hoffman's anodyne. *Dose*—20-90 m. Externally, ether may be used as an analgesic in neuralgia. For freezing the skin in minor operative procedures it has been superseded by ethyl chloride. Internally, it is administered as a carminative in colic and flatulence. Given hypodermically (10-30 m.), it is an excellent and rapidly acting cardiac stimulant in collapse, fainting, cardiac failure, and other emergencies. A few inhalations of ether will

often arrest hiccough and other local muscular spasms. It has also been recommended for spasmodic asthma. Good results have been claimed for large doses by the mouth or hypodermically in uræmia.

Sulphuris Iodidum. *See* SULPHUR.

Sulphurous Acid.—H_2SO_3. A colourless liquid with a sulphurous odour. *Dose*—½-1 ʒ. It is antiseptic, disinfectant, deodorant, and parasiticide. Rooms are commonly disinfected after infectious illness by burning sulphur so as to develop fumes of sulphurous acid. Foul sores may be washed with it; and such diseases as ringworm, pruritus, thrush, tonsillitis, and diphtheria have been successfully treated by it in varying dilution. It has been given internally in fermentative dyspepsia, typhoid, cholera, etc., but there is no proof that it really possesses any efficient action as a gastro-intestinal antiseptic.

Sumbul Radix.—Sumbul or musk root is the root of the *Ferula sumbul*, a plant of the Nat. Order of the Umbelliferæ, which grows in India and Russia; it contains *sumbulic acid*, *angelic acid*, *valerianic acid*, resins, and a volatile oil; and it has the general actions of volatile oils. The official preparation is the *Tinctura Sumbul* (dose, ½-1 fl. dr.).

Summer.—The hot season of the year, when certain maladies are common, such as *summer catarrh* (hay fever), *summer cholera* (epidemic cholera), *summer complaint* or *diarrhœa* (infantile diarrhœa), *summer rash* (*lichen tropicus*), *summer spots* (ephelides).

Sun Baths. *See* BALNEOLOGY (*Historical*); HYDROPATHY (*Hot Air*).

Sunlight. *See* RETINA AND OPTIC NERVE (*Retinitis from Exposure to Sunlight*).

Sunstroke.

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See also BRAIN, AFFECTIONS OF BLOOD-VESSELS (*Hyperæmia*); CHOLERA NOSTRAS (*Stools*); INSANITY, ETIOLOGY OF (*Direct Causes*); TEMPERATURE (*High Temperature, Effects*); UNCONSCIOUSNESS (*Sunstroke*).

DEFINITION AND NOMENCLATURE.—Under this title will be included all the acute pathological effects of exposure to excessive heat, solar and artificial. The more chronic results of prolonged residence in hot localities, or exposure to the influence of high temperature in sundry occupations, belong to the domain of climatology and tropical diseases or to the hygiene and pathology of particular industries. These results are mostly of slow and complex causation, and the operation of high temperature is generally associated with other concomitant and intermediary conditions which produce a wide and somewhat indefinite range of disturbed health, that may assume the form of general enfeeblement, or of some particular functional or organic disorder, most commonly of the heart. The more sudden and severe effects of exposure to great heat are of a striking and definite description, and present the phenomena either of shock or fever. Under these two categories all cases of sun or heatstroke are included. Cases of heatstroke may vary in intensity from simple exhaustion or slight transient fainting to profound unconsciousness and grave failure of respiration and circulation, rapidly established and quickly terminating in death. Cases of heat fever also vary in severity. The fever may supervene on shock, or originate *de novo*; may arise with or without prodromata; the actual invasion is usually sudden and the progress rapid; the temperature of the body soon attains a high level, and in aggravated cases symptoms of extreme urgency, presenting an apoplectic or asphyxial type, supervene and usher in early dissolution. The nomenclature of the subject is rather confused. Such terms as sunstroke, heatstroke, insolation, calenture, ictus solis, coup de soleil, and coup de chaleur are applied to either shock or fever of thermic causation of any sort or degree. The term heat-traumatism has been used by Manson to indicate the worst cases of shock and cases of fever with meningitis. The milder forms of fever have also been designated ardent fever. The severer forms of heat fever have been named thermic fever, thermic hyperpyrexia, heat apoplexy, and heat asphyxia. Siriasis (from Sirius, the dog star) is an ancient appellation which has been revived recently by Sambon, adopted by Manson, and associated with a hypothesis of specific type, epidemic incidence, and microbic causation. The name is a fanciful one, suggestive of sidereal influence, implying a faulty chronology, and bound up with an unproved etiology. Its continued use does not appear, under these circumstances, to be desirable. Maclean, following Morehead, recognises three types of heatstroke—the cardiac, the cerebro-spinal, and the mixed; the first two terms indicating heat shock and heat fever, and the third a combination of the two. These pathological designations are perhaps more definite than the phenomena justify. In the present state of our knowledge the simple

divisions and terms which have been indicated, namely, heat shock and heat fever, are sufficiently precise and explicit, and will be employed in this article.

Causation.—Excessive heat is the essential and dominant factor in causation. It is convenient to distinguish solar or luminous heat from high atmospheric temperature, whether derived from the sun or from an artificial source. From time to time assertions have been made that the influence of these two forms of heat upon the body differs, and since the discovery of the so-called X-rays by Röntgen, surmises have been advanced that the deleterious effects of luminous heat, especially on the nerve centres, are due to these or similar elements. On this subject no satisfactory evidence has been adduced; but as regards solar heat it is of practical advantage to discriminate between direct and indirect exposure, that is, between exposure to the rays of the sun or to a sun-heated atmosphere; because, apart from any question of the properties or powers of special rays, the heat of the unclouded or thinly clouded sun is considerably higher than that of the atmosphere, and there are grounds for believing that the element of glare intensifies the deleterious effect of radiant heat. The noxious effects of heat are not altogether measured by its degree, though intensity is a condition of prime importance. The experiments of Tillet, Fordyce, and Blagden in the last century, and of many observers in more recent times, show that the human body may be subjected unscathed to very high degrees of temperature provided that the exposure is not too prolonged and the individual is in sound health. Experience in tropical countries proves that an atmospheric temperature considerably exceeding blood heat and a still higher degree of direct sun heat may be endured for considerable periods by healthy persons without harm. There are other conditions — geographical, climatic, hygienic, and personal — which affect the influence of heat upon the body. Popular observation has determined that it is not frank dry heat within certain limits that injures, but moist, sultry, or "muggy" heat. It is not necessarily the hottest places, or years or seasons, as indicated by the thermometer, which produce most cases of sunstroke, and its geographical incidence is by no means a question of latitude or isotherms. The topical conditions associated with sunstroke are these:—an alluvial soil; a low level; a seacoast, river basin, valley, or ravine; a moist atmosphere; stagnation or stillness of air, and impurity thereof caused by jungle or swamp. Hot years and hot months are not so dangerous as years and times when both heat and humidity are high. It has been ascertained in India that the majority of cases of heat apoplexy in the European army occur not in the hottest months, but just before and after the rains, when much moisture is present in the air. It is possible, therefore, to define a geographical distribution of sunstroke, and Hirsch has collected a considerable amount of information on this subject, the accuracy and value of which is doubtful on account of uncertainty of diagnosis and the fragmentary character of the data. Sunstroke is necessarily more common in the tropics, because the essential factor of heat is there; and more common in some tropical countries, India, for example, and in some parts of these than in others, because the adjuvant conditions, topical and meteorological, are localised. Its occurrence in the tropics is by no means confined to the land; cases often occur in ships sailing in tropical waters—in the Persian Gulf and Red Sea, for instance—where excessive moist heat and glare and calms are apt to prevail. Cases and outbreaks also arise in overcrowded vessels, as in the examples from the French navy cited by Maclean. When sunstroke appears in temperate latitudes it is under conditions which may be truly described as tropical. Waves of heat of short duration often overspread parts of Europe and America in late summer or early autumn, which in cities, and among persons exposed to the sun in field labour, or when walking on hot pavements, or working in foundries and furnaces, are apt to prove disastrous. Such a heat wave passed over the Argentine Republic in February 1900. The air temperature mounted up to 104° F., the barometer was low, and the humidity over 50 per cent. In the town of Buenos Ayres, with a population of 795,000, there were, between the 1st and 13th of February, 1110 deaths, of which 121 were caused by sunstroke. Men were struck down as if by lightning. Similar experiences have been recorded in New York, Boston, and Philadelphia, and in Vienna, Berlin, and Paris. Most of these cases are of the nature of heat shock, but many of those not immediately fatal develop fever. In armies marching on service, or undergoing manœuvres during such heat waves, numerous cases of sunstroke, many of them fatal, are not uncommon. Hirsch gives many examples from European history, and a painful illustration occurred at Aldershot on the 11th of June 1900, when, during some manœuvres, out of a strength of 18,000, 300 cases of sunstroke took place, of which four proved fatal. Great heat is competent in the tropics, and even in temperate latitudes, to cause disaster on a large scale. In some parts of India, and in some years, hot winds blow which cause extensive mortality among natives of the agricultural class. This exceptional event is known among them as *loo marna* (wind stroke). The year 1868 was remarkable for the severity and deadliness of the heat, which affected animals as well as men. The influence of heat is materially modified by conditions of a communal and personal kind.

Overcrowding and defective ventilation, giving rise to a moist, impure air, are the most potent of these. The action of the skin and lungs, the principal cooling agents of the body, is impeded, the general health weakened, and the power of resistance crippled. Sanitary neglects, leading to atmospheric contamination and depressed vitality, are also important. Occupations involving labour in heat, solar or artificial, as in the case of stokers, predispose to injury by exceptionally raised temperature. Prolonged subjection to heat tends to diminish tolerance, owing, probably, to fatigued accommodation. The element of acclimatisation is also an important one. Communities and individuals whose lives and habits have not been attuned to high solar and atmospheric temperatures are apt to succumb when these rise suddenly and exceptionally. Racial distinctions are well illustrated by the statistics of the European army serving in India, as contrasted with those of the native army, and of native prisoners. The returns compiled by the Sanitary Commissioner with the Government of India for the years 1895-98 indicate an admission rate per 1000 of strength of the European army of 4·6, and a death-rate of 0·9, from sunstroke and heat apoplexy. In the native army the corresponding rates were 0·3 and 0·14, and the rates for native prisoners in all Indian jails were 1·0 and 0·4. These figures prove a considerable excess of liability and mortality among British soldiers, while the conditions as regards accommodation and exposure are more favourable for Europeans than for natives. The latter are by no means exempt from serious consequences entailed by exposure to thermic influences under unfavourable circumstances. Take as an illustration this extract from a frontier campaign by Fincastle and Elliott - Lockhart :—"The 35th Sikhs marched into Dargai *en route* to relieve the troops holding the Malakand Pass early on the 30th of July 1897, many of them so overcome by the heat that they succumbed immediately on their arrival. There was no ice, and the only water available was lukewarm ; and these stalwart Sikhs, nineteen of whom died, lay scattered about in every stage of heat apoplexy."

Closely related to the question of race is that of temperament. White races are more arthritic and sanguine than bilious or neuro-bilious dark races. Stout, full-blooded persons are less tolerant of heat than spare, wiry folk. Sexual liability is held to be considerably in favour of women, on account, doubtless, of the greater exposure of males to exciting causes. Children are comparatively exempt for the same reason. Women attached to the European army had, during the years 1895-98, an admission rate of 1·9 and a death-rate of 1·2, and children 1·1 and 0·5. The women, therefore, had fewer but more severe seizures than the men. New arrivals in tropical countries are more prone to succumb to heat than old residents, probably because of the better adaptation of the latter to their environment by habituation and habits. The statistics of the British army in India prove this ; but after a time protection seems to be lost and liability to increase. Resistance seems to be weakened by strain, and the power of adaptation seems to age as does that of accommodation of the eye. Of the more strictly personal conditions predisposing to sunstroke, alcoholism is the most serious. This is a well-established fact. Occasional or habitual excess impairs nervous power, predisposes to vascular irregularities, and in time damages organs and tissues concerned in processes necessary for maintaining a uniform temperature. Excess in eating, especially of animal food and fats, also tends to enhance liability. Clothing is of great importance from the points of view of protection of the head and spine, interference with respiration and circulation, weight and tightness, and impediment to cutaneous evaporation : the evil effects of unsuitable clothing and the wearing of heavy accoutrements, such as metal helmets, leathern stocks, tight, heavy cloth tunics and cross-belts, and weighty knapsacks are amply illustrated in the history of the British army. Maclean gives several striking examples in his lectures. Excessive muscular exertion causing fatigue is a most potent adjuvant of the worst effect of superheating. Muscular action generates heat, quickens respiration and circulation, and loads the blood with waste products, and fatigue impairs resisting power. It has also been found by experiment that the coagulation of myosin which occurs at a temperature of 113° F. takes place at a somewhat lower temperature in tired muscles. Pyrexia of malarious or other origin is likewise a strong predisponent on account of its debilitating effect, and mainly by reason of the upset of the thermotaxic function of the nervous system. Heat fever may be superadded to any other fever in the tropics, and the resulting hyperpyrexia is very deadly. The subjects of organic disease of heart, lungs, or kidneys are peculiarly amenable to thermic overthrow. Finally, depressed health, of whatever description or origin, lays its victim open to easy surrender to exceptional heat.

In most cases of sunstroke a combination of these causes is at work. The suddenness of seizures and seriousness of cases impart to the event an importance which the incidence and mortality even at the worst hardly justify. The victims are always a minority, often a very small minority, of a community. The partial and exceptional operation of a general cause is due to the element of personal susceptibility. Seizures, on the whole, present a sporadic rather than an epidemic aspect, and are apt to be simultaneous or to occur within a limited period which is strictly defined by the duration of

excessive heat. The incidence resembles, as regards communities, the effects of extreme cold, the conditions and causation being strictly analogous. When numbers are attacked in either case the resemblance to an epidemic is superficial and unreal.

Symptoms.—(1) *Of Heat Shock.*—Cases of simple heat exhaustion present great lassitude, accompanied by muscular pains, vertigo, nausea with pallor and weak pulse, and perhaps clammy sweating. Soldiers so affected have to "fall out" on the march, and to be left behind or carried. Heat syncope exhibits the usual symptoms of fainting. There is sudden unconsciousness, which may be more or less profound, the face is pale, skin cold and clammy, pupils dilated, breathing shallow and quick, pulse weak and rapid, temperature normal or subnormal. In severer cases respiration and circulation are more seriously affected and may stop suddenly. In other cases, when restorative treatment fails to bring the patient back to consciousness, signs of febrile reaction appear, flushing of a cyanotic character may succeed pallor, and a rapid rise of temperature with symptoms of heat fever supervene. Illness in these cases is often grave and protracted, and a fatal issue not uncommon. In simple cases of exhaustion or fainting, recovery is generally early and complete. Headache, giddiness, and lassitude may succeed the attack and persist for a time. Persons in bad health, or suffering from organic disease, are more prone to seizure, and the exciting cause may be either exposure to the direct rays of a hot sun or to superheated air. Cases of rapidly fatal shock usually arise from the action of radiant solar heat, and convulsive phenomena are sometimes observed. When thermic fever succeeds heat shock, symptoms of meningitis sometimes appear, and nervous sequelæ of a serious character, which will be subsequently described, often result. In all cases of sunstroke frequent thermometric observations should be taken.

(2) *Of Heat Fever.*—Ardent fever is a vague term which has been applied to any pyrexia presenting very active phenomena, such as pungent surface, high temperature, flushed face, noisy delirium, and bounding pulse. There is a hot-weather febricula in India which manifests symptoms of this kind; but how far heat enters into its causation it is difficult to judge. True thermic fever, or thermic hyperpyrexia as defined and described by Dr. H. C. Wood, is a disease of greater gravity, and characterised by very definite and uniform features. The onset of this fever is commonly sudden, and may occur during day or night, under exposure or in shelter—while marching or working, or resting or sleeping. Attacks in the army often occur in tents, barracks, or hospitals, and the first intimation of illness may be the stertor of coma rousing comrades from their sleep. Prodromata are present in a certain proportion of cases. They betoken nervous depression and disorder, and consist of giddiness, headache, lassitude, low spirits, sleeplessness, irritability of temper, anxiety, aural and visual illusions, muscular and arthritic pains, with, in some instances, anorexia and vomiting, hot skin, and quick pulse. Increased frequency of micturition has been described by Barclay and Longmore as a significant harbinger. Persons suffering from symptoms of this sort ought to be kept under careful watch. In many cases there is an initial stage of excitement. The temperature rises rapidly to 106°-109° F.; the face is flushed; conjunctivæ congested; there is great restlessness, often violent delirium; severe cephalagia, and the pulse is hard and bounding.

The fully developed attack, and it may set in without preliminary warning, may be described as a mixture of coma and asphyxia. Unconsciousness is profound; patient cannot be roused. The face is flushed, frequently livid, and the conjunctivæ suffused. The conjunctival reflex is lost, and other reflexes are dulled or absent. The pupils are dilated, normal, or contracted, and usually equal. In bad cases they fail to act to light, and contracted pupils often dilate towards the end. The skin is usually hot and dry, but may be bathed with profuse sweat. The breathing is rapid, often stertorous, with mucous rales, becoming irregular or intermittent (Cheyne-Stokes). The pulse is feeble and rapid, rarely slow, sometimes irregular or intermittent. The temperature is high, the thermometer marking 108° to 110° F. The bowels are usually constipated, but in some cases there is watery diarrhœa. Urine is scanty or suppressed, and may contain albumin, blood corpuscles, and casts. Subsultus occurs in many cases, and local spasms or general convulsions in some. Towards the close the sphincters may relax, the breathing becomes gasping and spasmodic, and finally ceases, and stoppage of the heart takes place soon after. The disease may run a fatal course in a few hours, and is seldom prolonged beyond a few days. Sometimes after partial recovery a relapse occurs which is generally fatal. In cases which recover the symptoms are of a less severe type, the temperature falls, reflexes if lost return, consciousness is gradually restored, and the patient's condition slowly improves. Convalescence may be very tedious, and nervous sequelæ of a severe and disabling kind may persist for long or for life.

Sequelæ.—All forms of sunstroke impair the power of resisting heat, and are also apt to weaken the tolerance of alcoholic stimulants. The after-effects of heat shock are generally slight and transient, but thermic fever frequently causes great and often permanent impairment of the nervous functions. Headache, giddiness, insomnia, loss of memory, diminished power of attention and concentration, and easily

induced physical and mental fatigue are common consequences, which may persist for months or years, but sometimes yield to time, prolonged rest, and residence in temperate latitudes. Irritability of temper, excitability and flightiness, emotional manifestations, altered habits, loss of self-control, and moral decadence are not infrequent results of severe seizures, and in persons of unstable nervous organisation intellectual or emotional insanity may ensue. Epilepsy is another of the graver sequelæ, and various disorders of sensibility, motility, and the special senses have been described. Persistent and incurable headache has been attributed to meningitis. A defect of articulation resembling that which is characteristic of general paralysis of the insane is occasionally met with, and this may be associated with a considerable degree of general muscular paresis. In such cases, of which the writer has seen several examples in the Netley Hospital among soldiers invalided from India, there is no exaltation, morbid euthanasia, or other indication of disordered intellect. From these various conditions, which affect mainly the higher neuron, incapacities of a serious and permanent kind may arise.

Morbid Anatomy.—Cases of heat exhaustion and syncope are seldom fatal, and the post-mortem appearances observed are said to be the same as in cases of syncope due to physical or mental shock of any description, namely, flaccid, dilated heart, distension of the abdominal veins, and perhaps some venous congestion of viscera possibly arising at or after death. The right heart is more dilated than the left and full of soft clot, and the arterial side of the circulation is comparatively empty. In fatal cases of heat fever characteristic and fairly uniform appearances are met with. The excessive temperature subsides slowly; after, perhaps, having undergone slight post-mortem rise. The surface is livid, and there is suggilation of dependent parts. Post-mortem rigidity sets in quickly. The body is prone to early decomposition. The heart is firmly contracted, and the arterial system empty while the veins are distended. Venous congestions are seen everywhere. The blood is dark and fluid, clotting imperfectly, deficient in oxygen, and inclined to acidity. The corpuscles are crenated and do not run into rouleaux; destruction of red corpuscles and phagocytosis have been described. The lungs are engorged to a degree not met with in any other disease. In cases of sudden death from exposure to great heat it is surmised that coagulation of the cardiac myosin has occurred before death, as has been observed by Claude Bernard, Sandes, Brunton, Wood, and others in animals subjected to excessive solar or artificial heat. Wood considers that coagulation of myosin in the heart, diaphragm, and other muscles is a post-mortem occurrence and associated with hyperacidity. No organic brain lesions, except signs of chronic meningitis in old cases, have been described. Von Giessen has observed a parenchymatous degeneration of the ganglion cells of the brain and spinal cord, which he attributes to the action of a toxin. Congestion, inflammation, and hæmorrhages are very rare, and if present are probably accidental or secondary. The brain tissue, as shown by Arndt and Nothnagel, is rather anæmic than hyperæmic.

Etiology.—Little if any advance has been made in our knowledge of the pathology of sunstroke since Dr. H. C. Wood wrote in 1872. The theories which have been advanced on the subject may be classed as dynamic, chemical, toxic, and microbic. The dynamic theory, which Wood advocates, recognises that the uniform temperature of the animal body is maintained by an adjustment of the balance between heat production or reception and heat dispersion—thermogenesis and thermolysis; and the nervous system, general or special, is the agent of adjustment — thermotaxis. Hyperpyrexia may result from increased thermogenesis, impaired thermolysis, or deranged thermotaxis, or from a combination of these. Healthy subjects have a high power of adaptation to great heat, but this power may undergo strain and fatigue, and the thermotaxic mechanism thus get out of gear. The theory obtains support from the fact that those conditions which produce susceptibility of the vulnerable minority are precisely such as increase production, impair dispersion, and derange the nervous balance; also from the impaired power of resistance established by one attack. The chemical theory postulates a change in the composition and structure of the solids and fluids, more especially of nervous tissue, wrought by heat. No organic or structural change has been demonstrated, with the exception of the acidity and coagulation of myosin of muscles, the ante-mortem occurrence of which is held to be rare.

The toxic theory, which is expounded by Maclean, assumes an alteration in nutrition, metabolism, and excretion, produced by thermic influence, which loads the blood with poisonous waste products, to the operation of which the hyperpyrexia is due. No doubt humoral impurities are produced in thermic and other fevers, but they are obviously of secondary rather than primary origin. Experience and experiment indicate that sound subjects may, under sufficient provocation, undergo the worst forms of heat attack without warning or antecedent ill-health. The microbic theory, advanced by Sambon, in the absence of discovery of any special micro-organism or toxin, is grounded chiefly on *a priori* assumptions and other logical arguments. Geographical limitations, specific phenomena, lesions, and sequelæ are held to indicate special causation; and comparison

with fevers of microbic origin presenting hyperpyrexia, to justify an assumption of similar production. The theory is not supported by positive facts, and is improbable. The dynamic theory, as ably developed by Wood, is most consistent with our knowledge of the circumstances and phenomena of sunstroke. Even if a toxic condition of blood were demonstrated as a primary factor preceding the onset of serious symptoms, its operation would still be governed by the agencies and processes which produce superheating of the blood, and it is quite certain that this superheating can be caused in both men and animals by heat alone.

Diagnosis.—Some difficulty may be experienced in deciding whether a patient who has been found unconscious after exposure to heat is suffering from the effects of heatstroke or from hæmorrhagic apoplexy, or from the results of alcoholic intoxication or narcotic poisoning. Perhaps, still further to complicate matters, more than one of these factors may be in operation. The hyperpyrexia is, under these circumstances, the key to the diagnosis. Greater difficulty may be experienced in distinguishing heat fever from a pernicious attack of malarial fever or hyperpyretic forms of eruptive and other fevers. It should always be borne in mind that persons suffering from pyrexia of any kind are not immune to heat influences—on the contrary, are specially susceptible to these; so that cases originally of some other fever may turn into heat fever. The history of the case is a valuable aid to diagnosis—more especially in suspected malarious attacks—and the observation in these of some indication of periodicity, the discovery of plasmodia in the blood, and the effect, if any, following the administration of quinine, should clear the issue. Convulsive phenomena in thermic fever may suggest cerebro-spinal meningitis; but careful inquiry as regards onset, examination of the patient, and study of the symptoms should dispel doubt.

Prognosis.—The mortality of heat shock is much lower than of heat fever. In the European army of India cases are registered under the heads of sunstroke, heatstroke, and heat apoplexy; the two former terms indicating roughly heat shock, and the latter heat fever. The case mortality is 9 and 25 respectively. Prognosis turns on the previous health of the patient, the severity of the noxa, and the gravity of the symptoms. Profound unconsciousness, absence of reflexes, convulsive phenomena, unyielding hyperpyrexia, and gravely embarrassed breathing are bad signs; but recovery sometimes takes place in very desperate cases, and after many days' hovering on the brink of death, and this justifies persistent effort and some measure of hope in the most unpromising plight.

Prophylaxis. — Racial acclimatisation is a long process of physiological adaptation taking place from generation to generation under the Darwinian law of the survival of the fittest. The habits of the acclimatised are an outcome of the operation of this law, and lend themselves to practical hygiene. The most noteworthy are indolence and apathy, fatalism, and a slavish adherence to custom and routine—betokening an instinctive avoidance of work and worry; a simple dietary, consisting mostly of grains, pulses, vegetables, and fruits, with sparing consumption of fish and flesh; temperance; light, loose, and porous clothing; head protection by means of turbans, umbrellas, wet cloths, thick leaves, etc.; early rising; work in the cooler parts of the day, and rest or sleep during the hotter; frequent bathing; shampooing and oiling of the skin; living in thickly thatched and shaded houses, and sleeping in the open. Many of these habits are worthy of imitation by persons entering on a tropical residence. When compelled to make unusual efforts, many natives of hot countries resort to opium and other nervine calmatives. In associated life in the tropics, the utmost pains should be taken to avoid crowding and promote cleanliness of habitations and their surroundings. Pure air and plenty of it is a prime desideratum. Houses and tents should be located in high, dry, and airy places, and ravines, swamps, and jungle avoided. Living and sleeping places should be as thoroughly ventilated as possible, and punkahs, thermantidotes, and tatties used. Soldiers should be marched in the cool of the morning, in open order, with frequent halts for rest and refreshment. They should be as lightly clothed and equipped as possible, and allowed to free their necks and chests of all constrictions. Tea or coffee, with a biscuit, should be given before starting, and the *bheesti* (water-carrier) kept in close attendance to supply drinking-water and douches if required. The sick and weakly should be carried in well-covered waggons, and those showing signs of exhaustion carefully attended to. Inspections should be held before starting to eliminate those not fit to travel on foot or horse. Horses and cattle are also liable to suffer from excessive heat if combined with fatigue, and require attention as well as the men.

Personal prophylaxis depends on avoidance of those influences and habits which have been indicated, under the head of causation, as predisposing to and aiding the noxious effects of high temperature. Exposure to great heat—solar, atmospheric, or artificial—should be rendered as rare and brief as possible. If symptoms arise in consequence of habitual or occasional exposure, such as headache, giddiness, lassitude, sleeplessness, and irritability of temper, prompt change to the sea or the hills or to a temperate latitude is advisable. During exposure to the sun the head and spine should be specially

protected. A great variety of hats and helmets has been invented and used, but for lightness and efficiency the pith helmet or *sola topi* is probably the best. A white cotton cover is useful, a *pugri* with fall over the nape is often added, a ventilating chamber and aperture are advisable, and the rim should extend well over the forehead, temples, and nape of neck. A little cotton-wool or a large fresh leaf placed in the crown is recommended. In view of the possible operation of X-rays it has been proposed to insert a thin metallic lining in the helmet; but some experiments made by Major Dick, R.A.M.C., at Netley indicate that metallic foil, even when doubled or quadrupled, does not arrest these rays materially, the number of the helmet on the opposite side being sharply photographed through it.

The spine should be protected by a plate of *sola* or a piece of cotton quilting which can be sewn into the coat. Clothing should be light and loose. Cotton is probably the best material for outer garments, and white the best colour, but some prefer jute, or silk, or flannel. The underclothing should be woollen, or a mixture of silk and wool, thin and cellular. Clothes should be changed as often as they get soaked, and the skin rubbed dry. "Goggles" are useful to prevent glare and the possible entry of harmful rays through the eyes. Food should be light and non-stimulating, and alcohol taken very sparingly if at all. Thirst should be liberally satisfied with cooled or iced water, or aerated drinks; tea is safe and refreshing. Physical fatigue and mental worry should be eschewed, and all influences avoided which tend to depress the health or spirits. Sleep is of great importance, and all arrangements and expedients conducive to it should be adopted. Moderate exercise is beneficial, and should be taken in the early morning or late evening. Violent exercise is dangerous. Bathing is an invariable daily habit in the tropics. Cold or chilled water is generally used, but under some circumstances may be risky. A tepid bath after severe exertion is more safe and soothing. It is important to guard against constipation of the bowels, and promote the free action of skin and kidneys. Late hours should be avoided, and work after dinner is apt to interfere with sleep. Any fever, malarious or other, should be promptly attended to and carefully watched. With good health and care, tropical heat, even of high degree, need not be feared, especially if dry.

Treatment.—(1) *Of Heat Shock.*—Persons suffering from heat exhaustion or syncope should be promptly removed to the coolest, airiest, and best-shaded place available, and laid in the recumbent position with the head low; clothing should be loosened, neckties, collars, belts, etc., removed, and smart douching of head and chest resorted to. Should fainting continue, ammonia inhalations may be employed, a little brandy and water administered by mouth or rectum, or a hypodermic injection of ether given. Flicking with wet towels and the application of brandy or mustard to the præcordium are sometimes necessary, and in obstinate cases artificial respiration may have to be used and continued until the breathing improves and consciousness returns. The pulse and temperature should be carefully watched, and subsequent exposure and exertion should be absolutely avoided in these cases, even when rapid restoration takes place. In cases of sudden and suddenly fatal seizures caused by acute direct exposure, as in the 98th Regiment in China and the 35th Sikhs at Dargai, no time or opportunity is given for treatment. If coagulation of cardiac myosin has occurred, treatment is obviously hopeless; but as long as there is any indication of life no case of sunstroke should be despaired of or abandoned.

(2) *Of Heat Fever.*—Reduction of temperature is the cardinal indication of treatment in thermic fever. The precautions as regards shade, posture, and clothing above noted should be promptly adopted. The application of cold to the surface by means of douching, spraying, packing, baths, ice-bags, towels wrung out of iced water, etc., should be immediate, effective, and sustained. The thermometer should be frequently used, and when a reduction of body temperature of 4° or 5° F. has taken place the cold treatment should be suspended or watched. If urgent cerebral symptoms are present, a turpentine enema is indicated. Unloading the bowels is advisable in all cases, and cold enemata assist in reducing temperature. In protracted cases rectal alimentation may have to be employed. The use of antipyretics is not advisable on account of their depressing effect. A moderate venesection may be tried in cases of dilated right heart and embarrassment due to distended venous trunks. Some physicians advise the administration of quinine as a routine practice. If there is any suspicion of malaria, quinine should be given in decided doses and repeatedly, preferably by subcutaneous or intermuscular injection. Digitalis is recommended by Chandler, forty minims of the tincture hypodermically. Pilocarpin has been injected in order to induce sweating when the skin is dry. Cautious chloroform and ether inhalations are the best means of moderating convulsions and spasms. Morphia and atropin have been injected in small doses for the same purpose. Prolonged change to a cool climate is imperative in cases of severe sunstroke. The sequelæ of sunstroke are best treated by rest, regimen, and climate. Counter-irritation, massage, and iodide of potassium are useful when symptoms indicate chronic meningitis.

Super-.—In compound words *super-* means above, upon, or excessive (Lat. *super*, above);

e.g. *superacromial* (above the acromion), *superabduction* (*excessive abduction*), *superalimentation* (overfeeding), etc.

Superciliary.—Above the eyelid, *i.e.* belonging to the eyebrows; *e.g.* the superciliary ridge (the bony prominence of the frontal bone corresponding to the frontal sinus).

Superfecundation.—The successive (non-simultaneous) impregnation of more than one ovum, possibly by different fathers, at different dates, but within the range of one menstrual period. *See* Superfœtation; Pregnancy, Multiple.

Superficial.—Belonging to the surface, not deep seated; *e.g.* the *superficial palmar arch* (*see* Arteries, Ligature of), the *superficial* veins (*see* Ascites, *Signs*, *Enlargement of Veins*), etc.

Superfœtation. — A problematical occurrence consisting in the impregnation of a second ovum from the next or some subsequent ovulation, the uterus being already occupied by the gestation sac from the former ovulation; superconception. *See* Pregnancy, Multiple (*Superfœtation*); Pregnancy, Affections of Generative Organs (*Malformations of Uterus*, *Double Uterus*); Superfecundation.

Superheated Steam.—Steam the temperature of which is higher than that which corresponds to the pressure under which the steam is formed; it is used in disinfection.

Superimpregnation.—The fertilisation of more than one ovum, resulting in twin pregnancy; in a special sense, polyspermy; this term includes both superfecundation and superfœtation (*q.v.*), but should not be regarded as synonymous with either.

Superinvolution. — Atrophy of the uterus due to excessive absorption of the tissues of the organ after labour or abortion; there occurs, as it were, an unusual degree of involution, so that a normal process becomes abnormal by excess. *See* Menstruation and its Disorders (*Amenorrhœa from Atrophy of the Uterus*).

Superior.—Lying above another structure, uppermost; *e.g.* the superior maxilla, the superior meatus of the nose, etc.

Supernumerary. — Additional or accessory, excessive; *e.g.* a *supernumerary auricle*, *supernumerary digits* or polydactyly, etc. *See* Ear, External, Diseases of (*Malformations*); Deformities; Heredity; Hermaphroditism; Physiognomy and Expression (*Supernumerary Parts*).

Supination.—The condition of the hand and arm in which the palm looks upward and the radius and ulna are parallel to each other; it is opposed to pronation; the muscles which put the hand and arm in this position are termed *supinators*, *e.g.* the *supinator brevis* and the *supinator longus*.

Supplemental Air.—Additional or reserve air; *e.g.*, in respiration the term supplemental is given to the volume of air which can be forcibly expelled after ordinary expiration is completed. *See* Respiration (*Respiratory Rhythm and Rate*).

Supply. *See* Ventilation and Warming (*Amount of Air*); Water (*Sources of Supply*).

Suppository.—Solid, medicated, conical bodies used for introduction into the rectum, vagina, or urethra; as a basis they contain oil of theobroma, rarely cacao butter or gelatin; there are seven official suppositories in the B.P.—those of carbolic acid, tannic acid, belladonna, glycerine, morphine, iodoform, and of lead. *See under the various drugs named. See also* Prescribing and Methods of Administering Drugs (*By Mucous Membranes*, *Rectum*).

Suppression.—Stoppage of a secretion, or obstruction to the escape of a discharge or excretion; *e.g.* suppression of urine, suppression of the menses, etc. *See* Urination, Disorders of (*Retention*, *Anuria*).

Suppuration.

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See also Abdominal Abscess; Abscess *and Cross References*; Aneurysm (*Complications*, *Cellulitis and Suppuration*); Ear, Acute Inflammation of Middle; Ear, Middle, Chronic Suppuration; Leucocytosis (*Ordinary*); Liver, Pylephlebitis; Micro-organisms; Oxygen (*Uses*, *Suppurating Wounds*).

Suppuration is the term applied to a process induced by the introduction into a living tissue of an extrinsic excitant which causes at its site a collection of serum and living leucocytes, most of which it kills, together with the tissues involved, as a direct or indirect result of its

action. When these phenomena are present suppuration may be said to have occurred, and the fluid which collects in the centre of their area of operation is called "pus." Suppuration is a relative term: there are microscopic conditions in which some observers would deny its existence, but all agree that suppuration has occurred where pus is visible.

It must be strictly borne in mind that in the early stages of suppuration, even a few hours after infection, the cellular constituents of pus are complicated by a proliferation of the cells of the part, and which therefore may be derived from connective tissue, epithelial tissue, or endothelial tissue, the exact variety depending on the site of the suppuration. It is necessary to recognise that there are other cells in the pus besides leucocytes, for two reasons: first, because it is not often possible to demonstrate pus without at least some of these tissue cells; and, second, because the presence of a cell is always an important feature in a process, the exact nature and significance of which is not thoroughly understood. When considering this point it is worthy of recognition that non-hæmic cells incorporate the micro-organisms of infection; and it is difficult to exclude these cells in defining suppuration when there is experimental evidence to show that there may be such a condition as local immunity, apart from general immunity.

Suppuration may complicate an "ulcer," but to say that suppuration may be a cause of "ulceration" would not be strictly accurate. It would be more correct to say that the same processes which end in suppuration may terminate in an ulcer, the surface of which suppurates. Suppuration may occur in pre-existing cavities, such as the pleural, peritoneal, meningeal, synovial, and endocardial cavities, in bursal sacks, and many bone-sinuses; when it occurs in a cavity of its own provocation the disease is called "abscess." Suppuration may complicate other morbid conditions, such as biliary, renal, and vesical calculus, and ulceration of malignant disease, when it must be looked upon as the complication of infection and not as a sign of these diseases.

Wherever suppuration occurs it may be "acute," "subacute," or "chronic." An acute suppuration may be said to be present when the process is mature in about seven to fourteen days; a chronic suppuration requires from one month to several months to mature; a subacute suppuration occupies an intermediate time in developing. It may be well to state here that these terms survive from a past era in surgery, when knowledge concerning the etiology of the disease did not extend beyond the limits of clinical observation at the time; these terms were chosen to indicate the length of time before the process of suppuration became manifest, and at the same time, by implication, the intensity of the disease. The essential difference, however, between one suppuration and another is not a question of time and intensity, but one of cause. It is now well established that the conditions to which each of these terms apply have a variety of causes.

Suppuration can be caused by many different kinds of micro-organisms. Suppurations may differ from one another clinically—they may be acute, subacute, or even chronic—and yet be caused by the same micro-organism, or they may resemble each other clinically although provoked by different kinds of micro-organisms, consequently a diagnosis of "suppuration" or "abscess" with no allusion to the causal micro-organism conveys an inadequate conception of the precise nature of the malady; this is more obvious when it is realised that it can be determined that suppuration is due to staphylococcus pyogenes aureus, or bacillus typhi, or bacillus mallei, and so forth. Such a precise diagnosis has a marked influence on the treatment and prognosis; hence the cause of the suppuration is an essential feature of the diagnosis, and a bacteriological examination is an indispensable part of the evidence upon which the diagnosis is established. From these observations it can be seen that the nomenclature of suppuration has not advanced simultaneously with increased knowledge of the subject. Doubtless in future the name of every suppuration will in some way be connected with the micro-organism or micro-organisms by whose action it is caused; in this way will be suggested the changes in progress besides the local lesion—changes without which suppuration itself would probably be impossible, and without which the mere liberation of the pus would be of no avail to stop the disease.

Kocher and Tavel have suggested the terms "staphylomycosis" and "streptomycosis" for infective processes due to staphylococci and streptococci respectively, and foreign authors seem to have accepted the titles. Perhaps it would be more precise to term the suppurations due to these micro-organisms "staphylopyosis" and "streptopyosis." It is, however, very difficult to apply to the many hybrid terms by which the different micro-organisms have gradually become known a method of nomenclature elaborated on this principle; the old nomenclature will therefore be retained in this article. The old names given to the varieties of suppuration when looked at in a new light are not without their bacteriological significance, for it will be seen that the micro-organisms which are the causal agents of acute abscess are only in exceptional cases the cause of chronic abscess, and *vice versa*.

Etiology.—Suppuration can occur only as a result of an external cause accidentally or intentionally introduced into the tissues of a living being. The excitant may be living or

lifeless. Although it is necessary to refer to lifeless excitants, the reader must appreciate the fact that it is with living excitants alone he will have to deal when treating a typical malady. To provoke any form of suppuration by means of a lifeless agent requires careful and elaborate preliminary precautions—precautions of a character so definite and essential that they render suppuration from this cause one of the rarest events in practice; to recognise the possibility of its occurrence is necessary, but beyond that the condition need only be regarded as an interesting laboratory experiment. There is no evidence to show that alterations in the biological conditions of animals will predispose to suppuration induced by lifeless agents. It will clear matters first to enumerate the lifeless excitants of suppuration; prominent amongst these are dead micro-organisms, products of micro-organisms, croton oil, pyrogallic acid, cantharides, carbolic acid, turpentine, and abrin; none of these agents are capable of multiplication in the blood or tissues of the body.

Prominent among the micro-organisms that occasion *acute suppuration* are the following:—

Staphylococcus pyogenes aureus.
,, ,, albus.
,, ,, citreus.
,, cereus albus.
,, ,, flavus.
Streptococcus pyogenes.
Bacillus coli communis.
,, pyocyaneus.
,, mallei.
,, typhi.
,, pestis.
Diplococcus pneumoniæ.
Micrococcus gonorrhœæ.
,, tetragenus.
Ducrey's bacillus of soft sore.

The most common of these are staphylococci and mixed infection of staphylococci and streptococci. It is comparatively rare to find an acute suppuration due to a pure infection of streptococcus pyogenes, and then, in the writer's observation, the suppuration has usually occurred in lymphatic vessels which were directly related to an area of erysipelas.

Among the micro-organisms that occasion *chronic suppuration* the almost constant excitant is the bacillus tuberculosis; indeed, chronic suppuration and tuberculous suppuration have become almost synonymous terms, and this too despite the fact that tuberculous suppuration, so called, is rather a process of degeneration than a true suppuration. Slowly forming suppuration can also be induced by oospora bovis (actinomycosis), bacillus mallei, bacillus typhi, etc. Some recent experiments by Kocher and others show that other micro-organisms usually capable of provoking acute or subacute suppuration may in certain circumstances cause semi-quiescent conditions that can only be termed chronic suppurations.

The micro-organisms which cause *subacute suppuration* are usually those of acute suppuration. On the other hand, occasionally a virulent action on the part of a micro-organism of chronic suppuration leads to this condition.

Other micro-organisms have been found in pus, but convincing proof that they are the causal agents is still wanting. To this category belong bacillus anthracis, bacillus œdematus maligni, and certain hyphal fungi, especially varieties of aspergillus and trichophyton.

Whichever micro-organism be the cause of any type of suppuration it usually gains entrance by means of a solution of continuity in one of the body surfaces. It is true Garrè rubbed virulent cocci on the skin of his arm and produced foci of acute suppuration, but there is a strong probability that in rubbing he made superficial wounds and inoculated them. The size of the wound is not of fundamental importance. Fatal suppuration may occur through the infection of a minute wound, and only slight suppuration may occur through the infection of a large wound; nevertheless, a greater degree of infection is likely to occur in a large wound. Any infected article that causes a wound may also infect it, or a wound may be made by a sterile instrument and afterwards become infected.

Modern bacteriological research has clearly proved that one and the same micro-organism may produce a great number of morbid conditions, hence it must not be supposed that inoculation by any of the above micro-organisms will result in one of the varieties of suppuration. Suppuration is produced only when several factors are so adjusted as to induce this result: these may be called the "regulating factors of infection," and can be divided into two groups:—

A. *Factors connected with the Micro-organism.*

1. *The particular Kind of Micro-organism.*—Some of those enumerated are more likely to cause suppuration than others; for instance, as already mentioned, staphylococcus is more likely to cause suppuration than streptococcus.

2. *Dose.*—The dose of those micro-organisms is very important whose virulence may be said to remain fairly constant. Although staphylococcus pyogenes aureus does vary in virulence, it is perhaps the most constant of all the micro-organisms that cause acute suppuration. Mr. Watson Cheyne has demonstrated that 250,000,000 are required to produce acute abscess in rabbits. Herman found that 500,000,000 staphylococci produced acute abscess in rabbits, and 50,000,000 produced the same result in dogs. It is, however, highly probable that these figures are very excessive in the case of man, who seems more susceptible to this micro-organism than the lower animals.

3. *Virulence.*—The virulence of a micro-organism is a more important factor than the dose when the virulence is subject to great variation in degree. It has been demonstrated by Marmorek and Dr. W. Bulloch that a culture of streptococcus pyogenes administered in a dose of 2 c.c. caused death in forty-eight hours, and that by increasing the virulence of the same culture a dose of half a millionth of a c.c. caused death in seven hours.

4. *Method of Inoculation.*—If the micro-organism be deposited in masses, its action is more sure to lead to suppuration than if it be injected in fine emulsion in a large quantity of fluid. The writer has not seen many cases of pyæmia, but the majority were admitted into hospital with pus in one or more places, and œdematous painful points in other parts which subsequently suppurated, and it was uncommon for a fresh undiscovered spot to become a focus of suppuration. If this is a correct and a common observation, it would appear that the foci of most subsequent sites of suppuration are inoculated early in the disease, in fact possibly at the time of primary infection. The blood or lymph streams may have been the combined or solitary paths of a general primary infection rather than the paths by which a local infection became disseminated and produced secondary lesions. The writer has never been able to induce pyæmia in animals, and therefore cannot speak from experimental evidence upon this point, but he believes there is reason to suppose that, if the mass of the micro-organisms inoculated has been from the beginning localised and not generalised, suppuration will remain local. Upon this point the writer has recently sought experimental evidence, and although pyæmia could not be induced, it was found that if an animal were killed five minutes after inoculation of staphylococcus pyogenes aureus in sufficient dose to cause only an acute local suppuration in a control animal, even then cocci could be demonstrated sometimes in the liver and sometimes in the spleen of the killed animal. Experimental evidence of this kind repeatedly led one to suppose that, although the mass of the injected micro-organisms caused an acute suppuration in the subcutaneous tissue at the site of inoculation, many of them became generalised at the time of injection, but gave rise to no morbid anatomical changes. This fact will be further alluded to in discussing recovery from suppuration.

5. *Nidus or Tissue in which the Micro-organism is deposited.*—Bone, periosteum, subcutaneous tissue, serous, mucous, and synovial membranes, are common seats of activity for the micro-organisms of suppuration. Some micro-organisms do not necessarily find a suitable nidus in all these tissues. Thus micrococcus gonorrhœæ does not act on skin and subcutaneous tissues, but it is most active on the mucous membranes of the urethra, conjunctiva, and cervix uteri, and it acts slowly on synovial and serous surfaces. A diffusing subcutaneous lymphangitis often clears up, leaving foci of suppuration only in the bursæ of its track (bursa patellæ and the bursa over the olecranon process of the ulna). In the writer's experience, the lips and cheeks are associated with fatal infection accompanied by isolated collections of pus more than any one part of the body. On three careful post-mortem examinations being made, the lower lips and lower parts of the cheek were involved in two of them, and the face and lips in the other one. There was no involvement in the pterygoid plexus, and the sinuses of the skull were free from disease; the lymphatic glands in the neck were involved and contained many micro-organisms. Streptococci existed in one case. The very vascularity of the part may be the essential factor in the cause of the danger of this site of infection. The exudation of fluid and emigration of leucocytes may be so large in amount and of such rapid accumulation that the capillaries become compressed by them, and hence the trouble. Micro-organisms of suppuration find uncongenial soil in hair, nails, cartilage, fibrous tissue, erectile tissue, and arterial tubes (excepting aneurysms). With regard to blood as a soil, it may be said that the infection is more likely to give rise to thrombosis than the thrombus to provide the soil for infection.

6. *Purity or Mixture of Infection.* — The action of some micro-organisms is more detrimental to the host in the presence of others; for instance, streptococcus pyogenes is more active if the bacillus prodigiosus be present, and the bacillus tetanus is more poisonous when accompanied by a mixture of infection.

7. *Dissemination.* — This is a complicated question, but the process is mainly facilitated when the micro-organism gains access to pre-existing channels, such as the blood and lymph streams, sheaths of tendons, and communicating synovial cavities. Dissemination is limited or retarded by the anatomical relations of the site of inoculation, if that be circumscribed by fascia or aponeurosis or bone. The motility and flagellation of micro-organisms probably have nothing much to do with dissemination.

B. *Factors connected with the Host.*

1. *Susceptibility* to infection by the micro-organisms of suppuration is relative. Two hosts in apparently sound health are not necessarily equally susceptible to the same dose of any one micro-organism. This natural difference may be increased by general or local disease or by injury.

2. *Immunity.* — Even in a protected host cold, fatigue, etc., render infection by any of the micro-organisms of suppuration more possible.

For inoculation to induce suppuration these regulating factors must be so adjusted that only that particular lesion can result: any alteration of adjustment, such as increased virulence of the micro-organism or increased susceptibility of the host, may produce a fundamentally different result, possibly a rapidly fatal result. The immediate effects of an infection depend wholly on the adjustment of the factors at the time of inoculation; the remote effects are profoundly influenced by that adjustment. The micro-organisms in the host may increase or diminish in number or virulence, and the susceptibility of the host may increase or diminish, but the starting-point of the increase or diminution is the state of the factors at the instant of inoculation. A subacute or chronic suppuration cannot follow an infection in such a dose that death ensues in a few hours. This necessary adjustment of the factors granted, the varying degree in which they are adjusted will influence the intensity of suppuration.

If an instrument has infected a wound, and all the regulating factors of infection are so balanced that an acute suppuration will develop, then suppuration is induced by the micro-organisms being deposited at the site of their future activity in one or several of the following methods:—

1. The micro-organisms may remain at the seat of inoculation, or

2. They may be carried from the seat of inoculation to any of the efferent lymphatic vessels; they may reach the lymphatic glands in which these particular vessels terminate, and thence may reach the general circulation.

3. The blood-stream may be the carrier of infection, and localisation may occur anywhere —in liver, spleen, bone-marrow, etc.—or at a part which has received more or less recent injury.

4. A duct or tube may be the path by which the micro-organisms gain entrance to those glands and viscera in which the suppuration subsequently takes place.

The *Pathological Anatomy*, *Symptoms*, and *Treatment* of acute suppuration will be discussed under the heading of acute circumscribed abscess.

Acute Circumscribed Abscess

An *Acute Circumscribed Abscess* is the result of an inoculation in a living tissue which provokes a rapid accumulation of pus within a cavity formed by the process, the excitant of which is localised.

Pathological Anatomy.—An acute circumscribed abscess consists of the following component elements:—

I. The micro-organism and its products.

II. The fluid contents or pus.

III. The tissues undergoing proliferation around the pus.

It is necessary to describe these elements separately.

1. The micro-organisms are the most important constituents of an abscess, and if their presence is not always demonstrable in the pus, they can generally be found in the abscess wall. The relations between the micro-organism, the pus, and the abscess wall necessarily depend upon the age of the abscess. One hour after an inoculation of staphylococcus pyogenes aureus (this is the micro-organism whose action will be dealt with throughout the description of acute circumscribed abscess) the cocci are seen chiefly in the parts immediately killed by the inoculation. They are almost limited to the dead and coagulated tissues and fluid (represented now by fibrin). This limitation is so marked that the coagulated dead tissues may be incidentally doing good by temporarily fixing the micro-organisms until their peptonising products liquefy these tissues: a stab culture of staphylococci in gelatin, a medium which holds them *in situ* until it is liquefied, is a somewhat analogous process. To proceed, a few cocci have escaped into the apparently normal neighbouring tissues, and already some of the cocci which have reached surrounding structures have been incorporated by the leucocytes that have just reached the edge of the healthy tissue, and are there collecting in small numbers around the necrotic area.

At the end of twenty-four hours the micro-organisms and leucocytes have increased in number. The micro-organisms are seen isolated and collected in masses among the dead tissues, and in and among leucocytes. The cell incorporation of cocci has increased with the increased number of micro-organisms and leucocytes. All parts are involved now, without regular arrangement, melted and mixed by the liquefaction that has taken place, the only stable parts being the more resisting fibrous tissue. Outside the liquefied area there can be seen free and cell-incorporated cocci, but in fewer numbers. Here and there the process is abruptly stopped by the fibrous tissue supporting the blood-vessels of the parts otherwise not yet involved. In the adipose and loose tissues the micro-organisms meet with less resisting soil, and there the process rapidly spreads. After the lapse of forty-eight hours from inoculation a definite arrangement of the staphylococci begins, and masses are seen collected in the form of a fairly well-marked tortuous ring *within* the outer circle of cells in the cavity of the abscess: these cells are chiefly leucocytes. The ring of cocci can be seen as a violet cloud under the half-inch objective when the section has been stained by Gram's method. As yet there is no definite connective tissue wall. A great proportion of the cocci apart from this well-marked ring are indiscriminately scattered in and among the cells suspended in

the fluid of the abscess cavity; a few are still to be seen outside in the tissues.

Between four and five days after inoculation the relation of the micrococci to the other components of the abscess remains practically the same, but much more clearly defined. The sinuous cloud of micrococci around the margin is more distinct; instead of being chiefly among leucocytes, it is now in an abscess wall, which is mainly formed from the connective tissue of the part (*see* Fig. 1). In this wall leucocytes also abound. Many more micrococci have become incorporated in cells. Such apparently is the permanent disposition of the micro-organisms in the abscess. Hence seven days after inoculation this relationship remains unchanged. The cell-incorporation of micrococci



FIG. 1.—This section of an abscess is under low power: on the right, *b* is the abscess cavity; on the left, *c* is the abscess wall, in which is seen the collected staphylococci in the form of a sinuous cloud. This abscess is seven days after inoculation.

has become more marked, but still a large proportion of the micrococci are free in the pus cavity. It is extremely difficult to demonstrate any cocci outside the now much-thickened wall.

At this point it is important to bear in mind the possible and probable behaviour of some of the micro-organisms immediately after subcutaneous inoculation, and hence days before the local effects result in the formation of an acute circumscribed abscess. In proof of this possibility the writer has frequently observed that in animals killed five minutes after they had been subcutaneously inoculated with a dose sufficient to induce an acute circumscribed abscess, the livers and spleens contained some of the micro-organisms inoculated. In most of the control animals inoculated with the same dose an acute abscess resulted. The presence of these micro-organisms, and the fact that they do no apparent harm, show the importance of recognising the value of the factors that regulate infection immediately upon inoculation. In the case of these generalised micro-organisms being highly virulent, death would ensue before an abscess had time to form at the seat of inoculation.

(Concerning the knowledge of the products of micro-organisms, see under "MICRO-ORGANISMS," vol. vi.)

II. The pus most commonly seen flowing from an acute circumscribed abscess is a thick, opaque fluid, white tinged with yellow, fatty or greasy to the touch, possessing a peculiar animal odour, and an alkaline reaction (sometimes acid in bone abscesses). It has a specific gravity of 1030, and patients whose abscesses have communicated with the mouth say it has an insipid, sweetish taste. This is the so-called "laudable pus." Pus is not always "laudable"; it may be thin and translucent ("ichorous"), or bloody ("sanious"). Flakes of coagulated material and dead tissue may be suspended in the fluid. The yellow colour of pus is ascribed to the fatty degeneration of the leucocytes and to the pigment of staphylococcus pyogenes aureus; when white it is ascribed to staphylococcus pyogenes albus. Sometimes pus is blue, this tint being due to the presence of bacillus pyocyaneus. The colour depends not only upon the micro-organism present and the fatty degeneration of the leucocytes, but also upon the tissue in which it develops. The pus of bone, for example, is often of grey leaden colour. The pus of a liver abscess is often chocolate or brownish from mixture with the bile pigment.

The odour of the pus varies. An acute abscess contiguous to the intestinal wall is often most offensive; if connected with the urethra it is often ammoniacal. By some the bacillus coli communis is supposed to be the chief cause of offensive smell, but this theory practically ignores the fact that this micro-organism may exist in purity in many odourless abscesses. The odour is often due to an infection mixed with non-pathogenic micro-organisms of putrefaction.

Gas may be present in pus as a direct product of micro-organisms, or owing to the abscess communicating with the respiratory or alimentary or genito-urinary tract.

The above variations of colour, reaction, smell, and so forth are supposed by some surgeons to be of value in the diagnosis and prognosis of the case. Thus "laudable" pus is supposed to indicate a good prognosis. It would be of advantage to be able to give weight to these characteristics, but implicit trust must not be placed in them. The evidence upon which to found a prognosis is bacteriological. The fact that an acute abscess is provoked by staphylococci is a better foundation for saying that it is likely to end in complete recovery, than a prognosis to the same effect based upon the

"laudable" nature of the pus, for "laudable" pus can be seen in acute abscesses due to bacillus typhi (typhoid) and bacillus mallei (glanders), etc.

To describe pus more minutely it must be separated into its solid and fluid elements.

A. The solid elements are held in suspension in the fluid, from which they can be separated by centrifugalisation or by filtration, after mixing the pus with an equal volume of a saturated watery solution of sodium sulphate which has been diluted with nine times its volume of water.

The cellular elements consist of:—

1. Leucocytes, in by far the greater proportion of all cells. The majority of the cells found in pus are the leucocytes that have left the blood system. The leucocytes circulating in normal blood are the following:—

(*a*) The polynuclear cell with neutrophilic granulations (Erhlich). This is present in the proportion of 70-73 per cent of all leucocytes.

(*b*) The lymphocyte, a small cell with large nucleus, present in the proportion of 22-25 per cent of all leucocytes non polyocytes.

(*c*) The coarsely granular polynuclear eosinophilic cell, present in the proportion of 3-4 per cent of all leucocytes.

(*d*) Large mononuclear cells devoid of granulations, the hyaline cell of some writers, present in about 1 per cent of all leucocytes. The nucleus is round or kidney-shaped in a comparatively large amount of protoplasm.

(*e*) Coarsely granular basophilic, mast cell (Erhlich), present in normal blood to about $\frac{1}{2}$ per cent of all white corpuscles.

Varieties *a*, *b*, *c*, and *d* of these cells are certainly amœboid; and *e* is almost certainly amœboid. Of these amœboid cells only the neutrophilic and the hyaline are phagocytic, that is to say, capable of incorporating live or dead micro-organisms.

The numerical strength of the neutrophilic cell suffices to make it the most representative cell of pus in acute abscesses.

Besides the neutrophilic cells, there are present in pus other leucocytes in a minor degree (minor, that is to say, as regards their numbers), viz. eosinophilic cells, lymphocytes, and hyaline cells.

Although white corpuscles may play an important part in immunity and in protection, there can be no doubt that their rôle is a fundamentally more complicated one than mere cell incorporation.

2. Red blood corpuscles are seen here and there, and care must be taken to exclude the possibility of their entrance during the hæmorrhage that occurs in the act of rupture or incision, but red blood corpuscles are present independently, and when present in any quantity they indicate great intensity of disease.

3. Young connective tissue cells, probably detached from parts of the abscess wall.

4. In the latter stages, plasma cells, corpuscles of Gluge, and fat globules.

5. Other cells of more doubtful origin.

Among other solid constituents are shreds of dead tissues, elastic and fibrous. Epithelial cells may also be found if an epithelial structure has been involved.

There is no necessity to describe here the preliminary changes seen in inflammation. By "inflammation" is meant those changes which occur in living tissues when they are affected by injury or infection. The writer defines inflammation in this manner because it is difficult to imagine an injury or an infection severe enough to cause the changes constituting inflammation without causing an element of death, however slight. Let it suffice to say, that before the leucocytes emigrate they are creeping along the sides of the capillaries and small veins, whilst the heavier red corpuscles occupy the axis of the blood-stream. In the arteries the rush of blood is too great to permit the same phenomena; in these vessels the white and red corpuscles and the various organised elements of the blood are hurried along together. In suppuration the neutrophile, the lymphocyte, the eosinophile, and the hyaline leucocytes emigrate by amœboid movement through the thin-walled veins and capillaries.

It will be seen in the article on inflammation that the transit of leucocytes from the blood is assisted by physical conditions, and possibly by active protoplasmic changes in the wall of the blood-vessel. Metschnikoff, who, as its founder, lays the greatest emphasis upon the importance of the phagocytic theory, points out how easy it is for a polynuclear cell (of which the nuclei are small) to pass out of a small opening, and how difficult the same process may be for a cell with a single large nucleus which may block its passage through an opening of the same size.

In a case of lieno-myelogenous leukæmia the writer has been able to observe the kind of cells collected in aseptic blisters, the myelocytes—a leucocyte typical of this disease—could in no single instance be found. This observation tends to show that the different forms of leucocytes react in varying degrees to different stimuli—a point considered in detail later.

Once they are out of the vessels the leucocytes soon collect in masses among the micro-organisms and dead tissue.

In the many preparations the writer has examined, the leucocytes are not at first seen inside the area immediately killed by the inoculation, but nearly all of them are collected immediately around the margin of the necrotic area, though a few have actually attempted an entrance. This can be seen one or two hours after a staphylococcus infection. After a few hours they become indiscriminately mixed with pus and liquefied necrotic tissue, the liquefaction of which is possibly in the first instance

responsible for the general dissolution inside the abscess cavity. All leucocytes having reached or entered the infected area immediately incorporate many of the invading micro-organisms, and may either digest them, or may themselves be killed by this intimate relationship. Apart from being killed by the organism actually included, many of the exuded cells, at first at any rate, are killed by toxic products, and may be seen spherical, breaking up, and undergoing granular, fatty, and other degenerations. Some observers state that they have demonstrated lardaceous degeneration in leucocytes and pus cells a few hours after infection. It is by no means easy to confirm these statements. In the early stages of abscess formation (*i.e.* the first two or three days) emigration is not by any means limited to the actual site of the micro-organisms. From many capillaries in the apparently normal neighbourhood leucocytes have emigrated, or are collecting in greater number than normal round the margin of the interior of the vessel walls. This is not so marked in the later stages (seventh day).

Since the discovery of the phenomenon of diapedesis by Cohnheim many ingenious attempts have been made to solve the problem as to what can be the power of attraction of the white cells towards the area of infection. In recent years new light has been thrown upon this complicated subject by experiments made on leucocytes, on many lower animals, and on many plants possessed of amœboid movements. It has been found that the direction of these movements can be profoundly altered by a variety of physical agents, such as light, contact, heat, galvanism, gravity, chemicals, atmospheric pressure, and so forth, these agents possessing the power of attracting or repelling the organisms of experiment. For example, the spermatozoids of ferns are attracted by certain chemicals (positive chemotaxis) and repelled by others (negative chemotaxis). The fact that bacteria and their products have been found experimentally capable of acting upon white blood corpuscles has been applied by Leber and most subsequent writers to the solution of the problems of inflammation and suppuration as seen in man and in the higher animals. However tempting it may be to accept these views, our present knowledge does not justify us in looking upon them as final.

B. The fluid element of pus is yellow, sometimes yellowish-green, and transparent; it coagulates on the addition of nitric acid, but it does not coagulate spontaneously; many of its constituents depend upon the micro-organism to which its formation has been due. Among many products of bacteria separated from artificial cultures made in media containing albumin and peptone, may be mentioned Buchner's mycoprotein, Leber's pylogosin, as well as substances separated by Brieger and others—products which are capable of provoking suppuration. A more important observation is that of Denys and van der Velde, who have separated "leucocidine" from the pleural exudate of rabbits inoculated with virulent staphylococci. These authors say it is a special and very powerful poison secreted by this organism, and that its action on normal leucocytes is to destroy them in a few seconds. On the other hand, if the exudate be heated for ten minutes at 60° C. the leucocytes are unaffected. The same authors have also obtained an anti-toxin capable of neutralising the leucocidine; this they term "anti-leucocidine." Like the blood-plasma from which it comes, the fluid element of pus contains no fibrinogen. It is richer in proteids than is ordinary lymph, the proteids being serum albumin and serum globulin; albumoses and peptones derived from the leucocytes and tissue cells destroyed by the toxic products of bacteria are also found. Lecithin is more abundant than in blood. Leucin and tyrosin have also been found. The fluid contains chloride of sodium, carbonates, and phosphates, to which pus owes its alkalinity.

The question whether the fluid of pus or the cells of pus possess some or any of the functions necessary to rid the host of the invading micro-organism or neutralise its products is discussed elsewhere. Apart from these possible properties, the fluid of pus serves to dilute the poison and flush out the diseased area.

III. Every circumscribed abscess has at first all the microscopical characteristics of a diffuse abscess, and it must be admitted that if a large dose of a highly virulent pyogenic micro-organism be inoculated into a susceptible host, an abscess wall of new formation is impossible all the time the micro-organism is infiltrating, killing, liquefying, and peptonising tissues with which it comes in contact. In a section of subcutaneous tissue, twenty-four hours after its inoculation with pyogenic cocci, will be seen micro-organisms, emigrated cells, and dead tissue massed at one spot in the adipose tissue; but there is as yet no wall. Nevertheless, the spread of the abscess, for such it already is, is here and there being abruptly stopped by the fibrous tissue supporting the larger blood-vessels which traverse the subcutaneous tissue. The stoppage is quite accidental; it depends on pre-existing tissue that happens to be there, and does not constitute a true abscess wall. This state of things continues till the end of about forty-eight hours, at which time, in the normal fibrous tissue surrounding the abscess, but not actually involved in it, there may be seen here and there young granulation tissue. Such young tissue is seen separating the fibres from and among which it is derived. Young vessels can already be seen in this new tissue. This is the beginning of an abscess wall. The particular connective tissue from which the

later definite encysting wall is developed is certainly the supporting dense fibrous tissue of the part. Fat and loose fibrillar tissue is generally seen to be undergoing degeneration and death, and offers little or no resistance to the attacking micro-organism.

After four or five days the fibrous wall has become quite definite, but in parts it is very thin. In many acute circumscribed abscesses the pus is more or less completely in contact with it, but in others has not yet reached it. In the latter case leucocytes and micro-organisms are traversing the adipose and loose tissue in an irregularly spreading margin towards the fibrous wall. By the seventh day the fibrous wall

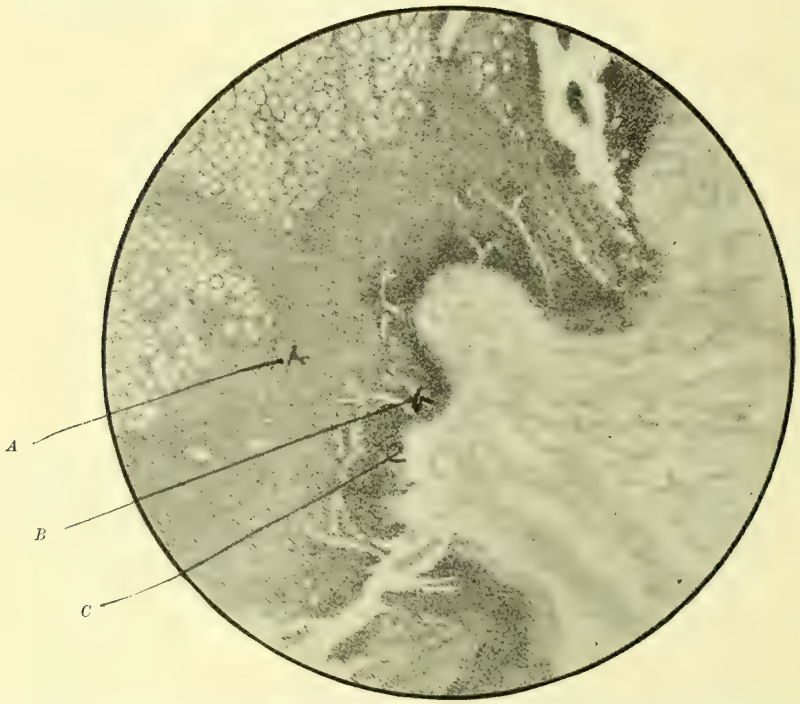


FIG. 2.—Section of an abscess seven days after inoculation. It demonstrates the three layers of the abscess wall: *A*, the external fibrous layer; *B*, the middle capillary layer suspended in fibrous tissue and pus cells; *C*, the internal layer of pus cells only.

shows marked increase of density, and fairly represents the appearance of the wall of a fully formed abscess, and in it are seen well-marked and organised vessels. This fibrous tissue becomes denser and wider and less vascular with increasing age. The pus is nearly everywhere in contact with it, and the wall shows three fairly distinct layers. These are from without inwards:—

1. A layer consisting of newly formed and vascularised fibrous tissue only (*see* Fig. 2).

The cicatricial tissue of an abscess wall is not only a repair of damaged parts, it is chiefly a new formation from existing and undamaged tissue due to the stimulus of irritants.

2. A layer of young connective tissue elements, among which are distributed in an inseparable crowd the same kind of leucocytes. It is in this layer that the chief clusters of micro-organisms which formed the previously described tortuous ring can be seen, and to this layer, under low powers, they are apparently abruptly limited. However, this is not really so, for a few can be seen in the next layer, and occasionally still fewer outside the abscess wall.

The blood-vessels from the outer layer extend into this layer and break up into a network of thin-walled capillaries which, in some cases, appear to be almost as large as sinuses (*see* Fig. 3). The capillaries are so feebly supported—merely by pus cells and a little connective tissue—that they readily rupture. They are the source of the hæmorrhage which occurs when an abscess bursts or is incised. In one large abscess this capillary hæmorrhage was so profuse that the writer had to plug the cavity.

3. A layer mostly of multi-nucleated neutrophilic leucocytes or pus cells, taking nuclear stains well.

The three layers at their margins merge one into the other.

By the seventh day an acute circumscribed abscess has frequently assumed an oval or circular shape, and encircling the wall just described is a concentrically arranged anastomosing network of newly formed fibrous tissue, the crescentic meshes of which are filled with adipose and loose connective tissue. The size of these meshes gradually diminishes the nearer they are to the abscess. The encircling arrangement of the abscess wall is caused by its own elastic property inducing centripetal pressure, and also by the centrifugal pressure exerted upon the wall by the gradually increasing collection of pus.

As the abscess advances towards the skin, but before it actually reaches it, many (and sometimes all) hair follicles, sebaceous glands, and sweat glands, and even the surface epithelium, atrophy from the subjacent pressure. Before the rupture of the abscess the pus burrows to a certain extent between the horny layer of the epithelium and the underlying layer of cells.

The length of time necessary for an acute circumscribed abscess to become fully developed depends upon its size and its depth from the

surface, and each of these conditions in turn depends upon the profoundly important factors concerning infection laid down under the heading of etiology. However, roughly speaking, the time taken by an acute circumscribed abscess to develop is from seven to ten days, perhaps a few days more, and, possibly, if the abscess be small and superficial, a few days less.

The sequence of events that occur in the formation of an acute circumscribed abscess can thus be summarised:—

(1) The introduction of the micro-organism.
(2) The necrosis of tissue.
(3) The exudation of fluid from the blood-vessels and emigration of leucocytes at first only up to, and after liquefaction into, the dead area, *i.e.* the abscess cavity.



FIG. 3.—Section of an abscess seven days after inoculation, showing the capillary layer in the abscess wall. It appears to be suspended in pus only, but with a higher power the capillaries are suspended by connective tissue cells among which pus cells are freely distributed.

(4) The formation of encircling membrane from the pre-existing fibrous tissue of the part.

This appears to be the most convenient place at which to remark that although the essential difference of one abscess from another is causal, the general significance—whatever it may be—of suppuration from all causes is probably the same in every case.

CLINICAL SYMPTOMS.—These are due to the absorption of toxic products, some of which are micro-organismal in origin, while others are derived from the broken-down tissues of the host. Their absorption is probably aided by the internal pressure of the abscess contents. The clinical symptoms may be divided into those which are *local*, and those which are *constitutional*.

Local.—After the inoculation—the fact of which may or may not be within the knowledge of the patient—the first notification of trouble is a feeling of tension in the affected part; at the same time the patient may complain of either a well-marked rigor, or feelings of chilliness, or an inclination to shiver. The local trouble increases into a definite throbbing pain, more or less spontaneous, the intensity of which is increased by making the part dependent, and diminished by its elevation or immersion in warm lotion. The lowering of the part will increase venous congestion, elevation will diminish it, and immersion in the fluid supports the over-distended capillary and venous systems. The pain now increases to extreme tenderness; there is a marked redness, which disappears on pressure and instantly reappears on its removal; heat, swelling, and hardness have also become prominent features of the lesion. The glands which receive the lymphatic vessels of the part in which the developing abscess is situated are next noted to be enlarged and tender, imparting a sensation of stiffness to the axilla, groin, or other site of affected glands. It is not always the lymphatic gland nearest the abscess which first becomes enlarged. From enlargement the glands may go on to actual suppuration, giving rise to the additional symptoms of an abscess at their site. Often, more particularly in streptococcus lesions, the lymphatic vessels leading to these glands are mapped out as diffuse, red, longitudinal streaks. Suppuration may occur in any part of the track of these vessels. In cases of lymphangitis of this nature the writer has frequently observed that bursæ—notably the bursa patellæ, and that over the olecranon—suppurate when no other secondary suppuration occurs; he has sometimes seen the occurrence when there was no suppuration even at the site of infection.

In the centre of the hard red swelling the redness now disappears slowly upon pressure, reappearing sluggishly when the pressure is removed. The red centre soon becomes blue, and appears soft to the touch; the fingers may now actually *pit* into it. This is the first trustworthy clinical sign that suppuration has occurred. The swelling grows more prominent and tense until *fluctuation* determines the fluid nature of the lesion. The skin shines from the polish of tension developed by the subjacent pressure. Around this tense and shiny swelling there is much redness and œdema, which gradually diffuse into the normal parts, and there disappear. The skin over the blue centre slowly becomes a thin, translucent membrane, through which the white or yellowish pus can

be seen, representing the familiar "head" of a pointing abscess. The skin at this stage may not look quite so tense and shiny, in fact the tension has now been relieved to a small extent by ulceration of the corium and deeper layers of the epidermis. The diminution of tension is indicated by a radiating network of very fine lines about the top and centre that can be clearly seen by the aid of a magnifying glass. In bad cases the function of the limb or part affected is quite abolished, and held rigidly still by unconscious muscular effort. The abscess is now quite mature, and upon the slightest movement or trauma bursts. At first the pus flows out, owing to the pressure to which it had been subjected; its escape is helped by the elastic property of the cicatricial tissue forming the abscess wall, also by the contraction of muscles in the neighbourhood. The surrounding redness disappears immediately upon the rupture of the abscess, and the other local signs rapidly subside. The abscess walls then fall together, from a continuation of the same processes which caused the evacuation of the pus, and from the influence of gravitation.

The gross effects of the micro-organisms are no longer visible, although the middle layers of the abscess wall are still crowded with the agents of causation. How long the residual micro-organisms can remain is a difficult question to answer, and a definite opinion cannot at present be expressed.

There is much difficulty in accounting for the property possessed by abscesses of spreading towards the skin. Many reasons are assigned, prominent among which are—

(1) They spread towards the least resistance; in this connection it is to be observed that the path of least resistance may lead to hollow viscera—intestine, bladder, pleura, or bronchus—and veins may similarly be invaded.

(2) The *vis a tergo* caused by the pulsation of arteries and movements of viscera and muscles. In connection with this point the writer has seen, especially in many cases of inflammation about the face, the advancing process spreading in oblique lines towards the skin, being conducted thither by the lymphatics around the blood-vessels that pass through the subcutaneous tissue for the supply of the true skin.

Constitutional.—Pyrexia.—Fever varies remarkably, the degree depending on the nature of the infection and the intensity of the process. The nature of the infection may be either septic intoxication—that is, an absorption into the blood of products of micro-organisms only—or absorption into the blood-stream of the micro-organisms themselves. In the case of human beings the former condition is more easily demonstrated than the latter.

A high temperature does not necessarily denote the existence of a large abscess, but rather may be taken to indicate the acuteness of the infection. It is not very rare to find severe and fatal infection and suppuration with a normal or subnormal temperature subject to only small variations. In mild cases the temperature remains fairly normal, but when pyrexia exists it generally assumes one of four types.

(1) *Sapræmic.*—In this condition the temperature begins gradually to rise immediately after infection, and reaches its highest point (103°-104°) about the third day. A daily fall of 1° ensues until normal is reached three or four days later; the whole cycle thus occupies about seven days, or often a much shorter time.

(2) *Hectic.*—This condition is characterised by a daily rise of temperature commencing at noon and reaching 104°-105° at about 6 P.M., followed by fall to subnormal by the next morning. The hectic state may or may not follow the sapræmic. The daily rise and fall gradually lessen in degree as the abscess heals.

(3) *Septicæmic.* — Here again the initial temperature may be sapræmic, or it may at once rise to 104°-105° and remain elevated, with daily intermissions that rarely fall to normal. The temperature falls, but with the same intermittency, as the abscess heals. In the event of a fatal issue it continues to rise sometimes to 106°-107°, and there may be a further rise of a degree or so after death.

(4) *Pyæmic.*—The initial temperature in this condition also may be sapræmic. After four or five days the normal temperature quickly rises during a rigor of 104°-105°. In a few hours the temperature is normal again, and there may remain until the next rigor. The temperature varies, however, and does not always conform to this scheme of regularity.

Leucocytosis.—This condition is marked in suppuration when not due to tuberculosis. It increases with the development of the disease, and subsides when pus is liberated. During convalescence the number of leucocytes in the blood sinks below normal (leucopenia). The presence or absence of leucocytosis may be of value in diagnosis, but in estimating its importance one must remember that in very slight and very intense processes it may be altogether absent. *See also* "Leucocytosis."

Constitutional Depression. — This is a marked feature of the disease; like all symptoms this state varies, but the sufferer from a large acute abscess feels and looks ill, and even approaches to the typhoid state. Rapidly increasing weakness and loss of weight increase the general appearance of profound poisoning. The writer has seen a case in which the absence of this constitutional depression had the effect of turning the scales from a wrong diagnosis of acute suppuration to a correct one of a rapidly growing abdominal cyst.

In human beings it is not easy to estimate

slight variations in blood-pressure, but in animals, Dr. Brodie and the writer have altogether demonstrated the marked fall of blood-pressure that occurs upon injection into the veins of large doses of virulent cultures of staphylococcus pyogenes aureus.

Amyloid disease is usually a sequel of suppuration. It must be observed that amyloid disease does not occur in prolonged cases of tuberculosis which have remained pure infections (*see* "Lardaceous Degeneration," vol. v.).

Diagnosis.—It must not be assumed that every thick white or yellowish fluid is pus because it looks like it. Fluid of this character may be caused by the suspension of epidermic cells as seen in dermoid cysts, or by other cells seen in the degenerations of malignant epithelial and malignant connective tissue tumours. Chylous fluid may give rise to error in diagnosis. The writer has seen the carpo-metacarpal articulation of the thumb in a man suffering from gout full of fluid thought to be pus, which was really composed of acicular crystals of uric acid suspended in altered synovial fluid.

The mere presence of an acute abscess can be recognised by the signs and symptoms already detailed. There are a few aseptic fluctuating swellings from which it should be readily distinguished.

(1) *Hæmatoma.*—This resembles an abscess in having a fluctuating centre and a diffuse œdematous margin; and leucocytosis may also be present if the hæmatoma is a large one. It differs from abscess in its sudden appearance after injury (necessary trauma may be slight in hæmophilics), in the absence of pain, heat, redness, pyrexia, and constitutional depression, and in the freedom from enlargement of the lymphatic glands.

(2) *Distended gall and urinary bladders.*

(3) *Collections of synovial fluid.*

(4) *Serous effusions.*

The three last named have well-defined margins. There is an absence of intense pain, redness, heat, pyrexia, and constitutional depression, leucocytosis, and in (3) and (4) more functional activity is possible than in suppurative lesions. The association of an abscess with aneurysm may be somewhat difficult to diagnose from an uncomplicated abscess. The nature of the case can be definitely settled by its history, by the suspicious anatomical relation of the suppurative process, and by the presence of a bruit and other signs of aneurysm.

Except by the history of the case, and upon the results of operation, it is often impossible to distinguish between hydatid and other cysts undergoing acute suppuration and a true acute abscess.

The simple recognition of a disease as acute abscess is not sufficient. Such a diagnosis does not include all the knowledge that can be ascertained concerning the malady. This inadequate recognition takes account only of a clinical condition, the existence of which may be due to a variety of agents. The specific agents are the essential foundation of a diagnosis. Certain clinical signs, however, may sometimes give a surgeon the clue to diagnose the actual micro-organism.

The existence of an acute abscess in itself is a step towards this clinical method of diagnosis, in so far as the process must be due to one of the micro-organisms of acute suppuration. The markedly localised and circumscribed abscesses, such as boils and carbuncles, are most frequently due to a staphylococcus infection, but an absolutely analogous condition may be brought about by bacillus typhi. Again, if the circumscribed abscess be complicated by lymphangitis it is possibly a streptococcus infection, but lymphangitis may also accompany the infection of a virulent staphylococcus. The cases in which the writer has found a pure streptococcus in an acute circumscribed abscess have been rare, and such an abscess has usually followed in parts that had recently been the site of erysipelas. Therefore a history of a previous attack of erysipelas at the same part influences the impression as to the causal agent of the new symptom of suppuration being due to the presence of streptococcus pyogenes.

The presence in the urine of staphylococci, streptococci, and bacillus typhi has aided the diagnosis of cases suffering from some lesion due to these micro-organisms.

The seat of disease bears on this subject; staphylococcic infection is liable to occur in arthritis, meningitis, osteomyelitis. But the writer has published a case of subacute abscess connected with the right sacro-iliac synchondrosis in a child of ten months, who recovered in six weeks, in which pure and virulent streptococci were found.

On good grounds Widal's reaction is regarded as a confirmatory process in the diagnosis of conditions due to bacillus typhi. In staphylomycoses and streptomycoses the writer has been unable to convince himself that the application of the homologous sera aids the diagnosis.

A complete bacteriological examination of the pus and abscess wall is essential as confirmatory evidence. In most cases of acute abscess examination of the pus alone will reveal the micro-organism, in others it is rarely found in the pus, but it is more certain to be found in the abscess wall. A notable example of the latter is Ducrey's streptobacillus of soft sore. Hence in all cases wall and pus must be tested. The examination ought to include staining, growth on artificial media, plate cultivation, and inoculation into animals.

To collect pus in a suitable way for this complete and rigorous bacteriological examination the writer now adopts the following plan:—By means of a sterilised flask alone the collec-

tion of pus is impossible without soiling the upper part, and so setting up connection that may lead to the contamination of the contents. To eliminate this source of contamination he uses a simple apparatus consisting of two parts—a long-necked flask within which is a piece of glass tube open at the ends, kept from movement by means of the cotton-wool plug with which the flask is stopped. This precaution of fixing the tube is of importance, for if it is movable it will shake about while travelling. The apparatus is then sterilised. The cavity containing the fluid is opened at an accessible spot by means of an incision conveniently directed, and the walls are held apart by blunt hooks. The inner or conducting tube is then drawn half-way out of its host, and by means of a pair of forceps is held in the cavity of the abscess at an angle which permits the pus to gravitate through it *to the bottom* of the receiving flask. When a sufficient quantity has been collected the inner tube is carefully and permanently removed; then the flask containing the fluid must be plugged again.

A portion of the actual wall is at the same time removed. In order to eliminate the possibility of contaminating the pus it is very essential that no skin is included in the portion removed.

Treatment.—The first object in all treatment is to determine the possible sources of infection. After a careful attempt to purify these sources an efficient dressing should be applied to them. By this means further infection will be excluded, and the very rare event of the continuance of suppuration after an acute abscess has been opened under all proper precautions may be avoided.

The management of acute abscess may be described as *local* and *constitutional*.

Local.—*Abortive.*—By some surgeons it is considered possible to abort an acute abscess. Unna's No. 88 plaster has the reputation of being able to abort boils and carbuncles. Wadding soaked in alcohol applied to the part and covered by mackintosh has been granted the same property. Squeezing the threatened spot has been said to act in this direction. Rest should also be part of this doubtful treatment.

Preventive.—Mr. Watson Cheyne has published cases in which he considers that antistreptococcic serum may have prevented infection. These were injected with serum previous to the radical removal of extensive cancer connected with sources of all sorts of possible infection, including that of streptococcus pyogenes. It should be observed that antistreptococcic serum is specific only for streptococcus pyogenes, and, as far as we know, disregards the toxins of other micro-organisms.

Palliative.—This treatment consists in first shaving the part, then purifying the skin, covering the abscess and the area for a wide space around it, and then keeping it poulticed with boracic lint that has been wrung out of boiling water solution of either perchloride of mercury (1-8000) or carbolic acid (1-40); applications of fresh fomentations must be continually made. The part must also be rested, and if possible elevated. Of course the situation of an abscess will necessarily regulate the treatment. Rest in the case of a limb is attainable by careful splinting, by placing the limb in the position in which there is least pain, and by carefully padding all the natural hollows that will otherwise exist between the limb and the splint. There seems no doubt that hot poultices hasten suppuration, heat apparently being the stimulating factor. If the dressings into which the pus discharges and the skin with which it comes in contact are both rendered sterile, then the pus remains uncomplicated with any other infection. As a rule, rupture of an abscess under these conditions will not be followed by any further escape of thick white pus, the pus being replaced by a diminishing discharge of serum that practically ceases in twenty-four to forty-eight hours. The use of poultices of bran, bread, linseed, carrot, charcoal, etc., is inadvisable, and should on no account be employed.

Operative.—Directly the surgeon is sure pus has formed, he should proceed to open the abscess. The skin, instruments, hands, etc., require as perfect sterilisation as in any other surgical operation. The seat of the incision usually selected is at that part of the abscess at which the skin is thinnest—in other words, where the abscess is "pointing." There may, however, be reasons for opening elsewhere. For instance, an abscess may be pointing on the margin of a cheek; in this case it would be wise to make an attempt to save the thinned epithelial covering by evacuating the pus by means of an incision below the jaw, so that the subsequent scar will be hidden. Again, it is necessary to make the incision as far away as possible from any source of sepsis.

The direction of the incision will also vary with the case, and when near them, it must be in the direction of vessels, nerves, ducts, and tubes, to avoid wounding these important structures. The length of the incision must always be sufficient to admit a small sponge, which should be used gently to break down septa that may separate recesses from the main cavity. In justice to his other cases a surgeon should not put his finger into a septic cavity unless absolutely obliged to do so. After all the pus has escaped, the inside of the abscess cavity should be carefully wiped out with a sponge wrung as dry as possible from a watery solution of 1-20 carbolic acid or 1-2000 perchloride of mercury; this procedure will take away some necrotic tissue left behind after the evacuation of the pus, and also most of the inner layer and some

of the middle layer of the abscess wall. Rest and splinting are as necessary here as in the palliative treatment.

In the operative treatment of carbuncle, in which adherent necrotic tissue is abundant, scraping with a sharp spoon is required. It is usual to apply pure carbolic acid to the surface thus exposed, but the writer has seen many cases do perfectly well without that precaution. In passing, it is worth noting this, because by the use of a sharp spoon the newly scraped surface is necessarily infected, and so the question of immunity, perhaps local, perhaps general, is wrapped up in the explanation of the favourable progress of the case in the absence of a powerful germicide such as carbolic acid. A carbuncle may be excised, and the resulting wound stitched up. But if too much tissue has been removed to permit of this course, the resulting wound can be skin-grafted at the time or, better still, at a later period. In the case of acute abscess, scraping out the interior of the cavity with a sharp spoon is quite unnecessary, and in fact only adds traumatism to an already badly diseased part. It is also said that scraping away an abscess wall may cause generalisation of infection. This, of course, is possible, but the precise value of the abscess wall will be discussed later. Washing out an abscess cavity with antiseptic lotions in order to kill micro-organisms is quite useless, because those actually killed or inhibited are a very small minority. Again, the main source of micro-organisms is left behind in the middle layer of the abscess wall which the lotion will not reach. Further, antiseptic lotions may act as irritants. In treatment the fact should be recognised that profound changes are occurring in the fluids and tissues of the host, upon which ultimate recovery depends.

Drainage. — Artificial drainage should be avoided as far as possible. The disadvantages of drainage are—(1) Tubes act as convenient tracks for the access of fresh contaminating micro-organisms. (2) As inert, lifeless foreign bodies, tubes are incapable of actively combating the micro-organisms in the cavity, and by this neutrality a tube will permit the existence and possibly the multiplication of such micro-organisms as become deposited upon it. The writer has frequently bacteriologically examined the serous discharges from healing abscess cavities, some of which were drained, while some were not; in all cases the causal micro-organisms were not only present as long as the discharge continued, but were also virulent to lower animals. (3) After a very few hours the only part of the abscess cavity drained is that which is in actual contact with the tube. If drainage tubes be employed, they should be as large as possible and discontinued early. The indications for the removal of a tube are diminution of discharge, and the natural expulsion of the tube by the contraction of the cavity and the granulation tissue. However, a drainage tube is essential in a deeply situated abscess. Care should be taken that the external extremity of the tube is level with the surface of the skin.

Hilton's method of opening an abscess is usually adopted in those cases where the pus is deeply situated and is in close proximity to important structures. Here an incision is made over the region, and the tissues are carefully divided in layers till the dangerous area is reached. A pair of sinus forceps is pushed into the cavity, and in withdrawing them the aperture is dilated by opening the blades in the direction longitudinal with the structures it is necessary to avoid. The freely escaping pus and the superjacent tissues may hide the opening into the cavity if the hole is not marked by inserting a probe before permanently withdrawing the forceps.

Dressing.—This should be the same as applied to an ordinary aseptic wound. When abscesses are opened by the above methods, fresh tissue spaces, lymph-vessels, and blood-vessels are opened, and generalisation of the micro-organism will, it is said, be rendered possible. The writer has never seen this occur after opening an acute or subacute abscess. It is often necessary to cut through the healthy tissues in order to reach an acute abscess. But these tissues immediately heal without signs of infection, as quickly as though no microbes had traversed them. As will be later pointed out, some important questions of artificial immunity and protection possibly arise out of this fact. Some foreign surgeons lay great stress upon the importance of this possibility of infection to generalise, and to prevent it, open abscesses by slowly burning a passage into them by means of some form of actual cautery.

Constitutional. — A purge may be administered at the commencement of treatment, and the bowels should be subsequently kept open by mild laxatives. Nourishment should be constantly given in an easily assimilable form; this, together with fresh air, is the most important feature of constitutional treatment. Change of air, particularly change to the seaside, sometimes stimulates repair when progress is delayed. Tonics, quinine, iron, bark, may be required. The internal administration of yeast is a remedy which has in some hands met with success in cases of boils, that is to say, in staphylococcic infection. Stimulants should be employed when indicated.

Serum Treatment.—In streptococcic abscesses the question will arise as to the advisability of exhibiting antistreptococcic serum. The writer has frequently injected this serum in cases of pure and mixed streptococcic infections, but he has never seen the least benefit result from its employment. If this particular serum, in its present condition, has any use in surgery

it is only as a preventive, and not as a curative agent. Dr. William Bulloch and the writer of this article have attempted to produce a serum that would protect against staphylococcus. A mare was inoculated with virulent staphylococci, and her blood was subsequently tested at different periods, but with no positive results, for it failed to cure or to protect. Judging from the meagre accounts published by other observers (Viquerat and others), a serum similarly prepared has, in their hands, given positive and promising results.

In all the pathological processes that end in recovery there must be a physiological aspect, and this is especially so with regard to infectious diseases, to which class of affections abscess certainly belongs. It has been pointed out that when an abscess has burst or has been opened in circumstances in which fresh infection has not occurred, it will, as a rule, heal without further discharge of pus. It is at present impossible to explain satisfactorily the reasons for this fact. Further, it is impossible to say why suppuration ceases. As will be seen, it is more easy to state what are not causes of recovery.

Now the effects of the evacuation of the pus are: (1) the relief of tension, (2) a diminution in the number of micro-organisms, and (3) the removal of their and other toxic products. It has already been pointed out in this article that after the pus leaves an abscess there still remains a great collection of micro-organisms. The mere liberation of pus, then, cannot account for the cure of the disease. There are micro-organisms left behind sufficient to promote numberless acute abscesses. The remaining micro-organisms are seen in greatest numbers in the abscess wall, but can be demonstrated also in fewer numbers in the surrounding tissues and in the serous discharge. It may be suggested that the biological conditions of the remaining micro-organisms are adversely influenced by the contact of antiseptics, but in discussing the best treatment for acute abscess it was pointed out that antiseptics could not reach the micro-organisms.

It is well known that some micro-organisms in passing through a series of hosts gain in virulence, while others lose virulence in the course of the same process. The writer has found that staphylococci invariably lose virulence during passage through animals. Can it be that an abscess gets well because the micro-organisms of suppuration lose virulence? In attempting to answer this question, it must be remembered that in the serous discharge from healing staphylococcic abscesses in man, not only were the micrococci present, but the writer found them to be very virulent and capable of killing animals if inoculated in the usual doses. The same virulence continued if the abscesses were prevented from healing by the insertion of drainage tubes. In human beings it is impossible to estimate the virulence of the initial dose, and without this standard it is impossible to say definitely whether it has gained or lost in degree. In the necessarily few days during which the writer has been able to observe it in *healing* abscesses, the virulence has always been fairly maintained. Another fact of importance is that experimentally many micro-organisms that cause acute suppuration can be shown to *increase* in virulence during their passages through animals. The virulence of streptococci is rapidly and greatly increased. Further, the writer has been able to observe the virulence of the bacillus mallei in a case of glanders for a period of nineteen months. In the tissue removed at the last operation (after which the patient left the hospital quite cured), the bacillus mallei was as virulent as when first tested on the man's admission. Pus, granulations, and fluid cultures gave the same result, viz., retention of virulence; so progressive loss of virulence of the micro-organism cannot have been the reason of recovery.

The retention of virulence is also possible in the case of an abscess that forms after typhoid fever and due to bacillus typhi. A case has recently been under the observation of Dr. William Bulloch, in which the patient has a sinus that has been discharging for nine months. The sinus contains an extremely virulent bacillus typhi, yet in spite of this fact the patient is apparently in good health. It seems, then, that the micro-organisms may, under certain conditions, retain their virulence, but lose their power of acting poisonously upon the affected person. It must, therefore, be supposed that the tissues have lost their property of being acted upon, and that they have generated certain antagonistic properties by which the invading micro-organisms are rendered comparatively inert.

There are some reasons that make many surgeons and bacteriologists attach much importance to the protecting influence of the abscess wall. They look upon it as a barrier between healthy tissues on the one side and the disease on the other. The idea receives some support from the fact that a great collection of micro-organisms is abruptly demarcated by the abscess wall. In a fully developed abscess the wall is certainly at any rate a mechanical barrier. But an abscess in its early stages is without a wall: while the micro-organism is infiltrating and killing tissues an abscess wall cannot form if these circumstances continue. It can only form when the micro-organism has lost some, at any rate, of its destructive power. If this is so, it must be assumed that the wall only forms round an irritant as it would round a foreign body, and that for *special* protecting work it can have no more specific value than any other tissue of the host.

In the case of the accidental infection of operation wounds, the temperature and constitutional symptoms gradually subside till the third or fourth day, when they disappear. It is said that because the abscess wall is gradually forming during this time the constitutional signs gradually disappear. This looks at first an important reason, but it must be borne in mind that when the temperature *first* begins to fall the defeat of the micro-organism or its toxins has probably begun, and at that stage there is no abscess wall. The gradual subsidence of temperature in typhoid fever is not supposed to be the effect of a barrier forming round the lesions, and the sudden fall of temperature in pneumonia cannot be due to the formation of a protecting membrane. Then again, even in the presence of a very thick fibrous abscess wall severe hectic temperature can last for months: this does not look like protection.

Many experiments have been made to support the protection theory of the abscess wall. Prominent among these are the experiments of Afanassieff. This observer inoculated various micro-organisms on to granulation tissue carefully protected from injury, and found, among other very interesting facts, (*a*) that no general infection took place, (*b*) that the animals so inoculated were not susceptible to subsequent infection with virulent culture of the same micro-organism even when applied to fresh wounds. Immunity had thus been induced.

Afanassieff states that these experiments prove the specific protecting property of granulation tissue (or abscess wall). Let the results of the experiments for a moment be granted. As far as the writer is able to construe these results, he would say Afanassieff's second statement (*b*) directly negatives his assumption, and proves a general immunity, and not a local one; and further, that the abscess wall shares its property of resistance with the rest of the animal's body, part of which it undoubtedly is. The writer of this article had been inoculating animals with cultures of staphylococcus pyogenes aureus with a view of testing the same question; and after a series of experiments the results left him with the impression, that when an abscess has well formed (after six or seven days), it may require more than double the dose of a tested virulent culture to provoke an abscess elsewhere in the subcutaneous tissue of the same animal. This increased dose often induced no obvious local changes. In a few cases the same dose induced a serous effusion that disappeared without rupture. Further, this capacity of resistance was quite temporary, and disappeared in probably less than fourteen days, leaving the animals as susceptible as ever.

Perhaps the protecting value of an abscess wall has been over-estimated. With some justification an observer may be pardoned for looking upon it as a membrane through which highly toxic products can leak into the system. And instead of protecting the host, it may really hinder the evacuation of these products by closely encircling them. The fact that boils constantly occur in uninterrupted sequence seems at first sight to negative the argument of immunity or protection, but even here either immunity or protection—it may be but of a transitory nature—is probable, since the process eventually ceases. Our present knowledge of the relation between the causes of suppuration and immunity is so scanty that a discussion of the subject is of little value, but there are facts which point to intimate relations between them. Fehleisen showed, in experimenting on the value of streptococcic infection in the treatment of cancer, that his patients were rendered immune to that micro-organism for from three to five weeks. It is also found that abrin applied to the conjunctiva confers local immunity against abrin, but not general immunity. Whatever may be the value of these and other experiments, clinical observations lead one to the inevitable conclusion that the healing of an acute circumscribed abscess will remain inexplicable until the vexed questions of immunity and acquired immunity rank among those problems that are solved.

Acute Diffuse Abscess

An acute diffuse abscess is the result of an inoculation which rapidly provokes an accumulation of pus within a cavity resulting from the process, the excitant of which is infiltrating.

The etiology and pathological anatomy vary in degree only from those of acute circumscribed abscess, the variation being an increased intensity of the process, which may be due to—

(1) A comparative increase of the capacity for action on the part of the micro-organism.

(2) A comparative decrease of the capacity for resistance on the part of the host.

(3) A combination of these phenomena.

The result is a burrowing, ramified cavity containing pus.

The spread of the micro-organism occurs chiefly in the soft connective tissues, and is at first limited by the mechanical resistance offered by the dense connective tissues—fasciæ and bone; but the natural cessation of the process of diffusion in soft connective tissues depends upon the more profound changes that take place in the relation between micro-organism and host—changes to which reference has been made in the article on "Acute Circumscribed Abscess." Death of the host may occur before the final arrest of the process of diffusion. Multiple acute diffuse abscess may be (*a*) *Primary*, the result of immediate generalisation of the initial dose; (*b*) *Secondary*, the result of infective emboli (*pyæmia*). However caused,

these abscesses vary in size from isolated collections of a few leucocytes to cavities containing pints of pus.

Clinical Signs and Symptoms.—*Local.*—In the case of a superficial diffuse abscess the skin covering it is painful, red, hot, and œdematous, and the part is swollen. The margin is diffuse. Evidence of suppuration and the approach of pus to the surface is indicated by the detection either of a soft spot in the otherwise brawny tissue or of definite fluctuation. A rapid and extensive accumulation of pus produces gangrene of the skin by destroying its blood-supply. The presence of a deeply situated, diffuse abscess is marked by pain, increase in size of the part, and œdema of the superjacent skin. *Crepitation*, caused by the presence of gas, is a sign only rarely met with in abscess, but it is commoner in the diffuse than in the circumscribed form. It is due to one of two causes: the gas may have been generated by decomposition of the abscess contents, or it may have gained entrance to the abscess cavity by means of a communication between it and the respiratory or digestive tract.

The *constitutional* signs are the same as those of acute, circumscribed abscess: they vary in severity; they may be hectic, pyæmic, or septicæmic; or, even in severe and fatal cases, marked disturbances of temperature may be altogether wanting.

Treatment.—*Local.*—The general principles of treatment are similar to those described in the article on "Acute Circumscribed Abscess." The incisions must be free and extensive; this is especially desirable in those cases in which the skin is likely to become gangrenous; if extensive gangrene occurs, skin-grafting is necessary after the separation of the dead tissues. Dependent incisions and drainage—with the largest tubes—are essential where putrefaction exists. In spite of these measures diffusion may extend and necessitate further incisions combined with local antiseptic baths, or hot antiseptic poultices frequently changed. In desperate cases, such as rapidly spreading glanders, the application of pure carbolic acid, of nitric acid, or the actual cautery to the internal surface of the cavity is indicated. *Constitutional treatment* calls for special attention, particularly with regard to fresh air, change of air, nourishment, stimulants, etc.

Subacute Abscess

The term subacute abscess is applied to a condition in which the accumulation of pus occurs in about two to four weeks; it may be induced by a slowly acting micro-organism of acute suppuration or a rapidly acting micro-organism of chronic suppuration, hence the *pathology* and *treatment* are the same as of acute suppuration and chronic suppuration respectively.

Chronic Abscess

The term chronic abscess is applied to suppuration slowly provoked within a cavity formed by the process, the excitant of which may be localised or locally diffusing.

Etiology.—The almost constant excitant of this condition is bacillus tuberculosis; indeed, chronic abscess and tuberculous abscess have become almost synonymous terms, and this too in spite of the fact that the tuberculous process is not a true suppuration: the tuberculous process is rather a caseation of newly formed chronic inflammatory tissue. True suppuration may occur in a tuberculous abscess if the infection become mixed by the entrance of one of the micro-organisms of acute suppuration. It must, however, be stated that slowly forming abscesses can be induced by oospora bovis (actinomycosis), bacillus typhi, and even bacillus mallei. Some recent experiments by Kocher and others show that micrococci, usually capable of provoking acute or subacute suppuration, may in certain circumstances cause semiquiescent conditions that can only be termed chronic abscesses.

Pathology.—Dr. Whitfield and the writer have been studying the cellular flora of chronic inflammatory lesions. It is out of place here to enter thoroughly into our results, but it may be said that the emigrated leucocytes appear to us to be lymphocytes chiefly, and there is present a great number of plasma cells together with a great amount of organised and degenerated connective-tissue elements.

Diagnosis.—A slowly formed abscess when of tuberculous origin is distinguished by the comparative thickness of its walls. The diagnosis of the tuberculous origin of an abscess may be assisted by the reaction of the individual to tuberculin; of course this means is only to be resorted to in isolated and obscure cases. Leucocytosis in tuberculosis is uncommon; on the contrary, eosinophile leucocytes are often either absent or diminished in number. The presence of a hectic temperature and amyloid disease are not signs of tuberculous infection, but they are signs that the condition is either non-tuberculous, or tuberculous with a mixed infection superadded. Amyloid disease must be very rare in pure tuberculous infection: the writer has never seen it. Confirmatory evidence is provided by a bacteriological examination of the abscess wall, which is more likely to give definite evidence than the pus. With regard to typhoid and actinomycotic abscesses the reader is referred to the article on these diseases.

Treatment.—The ideal treatment of a chronic tuberculous abscess is complete excision without disturbing the contents. When the abscess is connected with bone—as it often is—such a procedure cannot be carried out unless it be practicable to remove the bone as well—as in

the case of a rib. If the abscess be small and superficial, and it is impossible to remove it in its entirety, remove as much of the abscess wall as possible, and drain the remainder. If the abscess be large, as in the case of a psoas abscess, it is safer to open it, wash it out with an aseptic solution, and sew up the incision. Re-collection will very likely occur; directly it is ascertained with certainty the same procedure must be repeated before the pus has time to accumulate to the same extent as at the preceding operation, but at each successive operation the sac will be found smaller than before. The alternative treatment is to incise the abscess and drain it. The advantage of the former over the latter method is that extra infection is guarded against, whereas the presence of a drainage tube provides a pathway for fresh infection.

ANGINA LUDOVICI

The term *Angina Ludovici* is loosely applied to varieties of diffuse infective inflammation of the median and lateral aspects of the neck. When bacteriologically examined it has generally been found to contain streptococcus pyogenes, or one of the varieties of staphylococcus, or a mixture of these, or pneumococcus; other bacteria have also been discovered resembling bacillus diphtheriæ and actinomycotic organisms. The source of infection may be the mouth, nose, pharynx, scalp, tonsil, or ear. The disease apparently exists in the loose connective tissue, not in the lymphatic glands. It generally begins about the chin or angle of the jaw (in the region of the submaxillary gland), and spreads downwards with a very diffuse margin. The neck becomes red or dusky, sometimes almost blue in colour, tender, swollen, and hard. In slight cases there is only a feeling of discomfort about the neck; in severe cases there is much pain, dysphagia, and dyspnœa. The disease is subacute rather than acute, the fever being usually slight, but increasing with the intensity of the lesion. The case may not suppurate, the condition lasting for weeks, with slow resolution; in severe cases death may occur early without suppuration. If suppuration take place it may be at only one small spot within the brawny mass, or the whole lesion may be involved in a large, diffuse abscess. *Treatment* calls for no special remark; unless suppuration occur, incisions do not seem to shorten the course of the disease, though they may assist in preventing its spread. This type of diffuse inflammation is not limited to the neck, but wherever it occurs care should be taken to exclude as the causal agent the bacillus œdematus maligni, a micro-organism which induces non-suppurative inflammation of a virulent and rapidly fatal type.

Supra-.—In compound words the prefix *supra-* (Lat. *supra*, above) means above or upon; e.g. *supra-acromial* (above the acromion), *supra-axillary* (above the axilla), *supra-auricular* (above the external ear or auricle), *supra-clavicular* (above the clavicle), *supra-condylar* (above a condyle), *supra-glenoid* (above the glenoid cavity), etc.

Supra-anomalies. — Anomalies (structural or functional) by excess, as contrasted with infra-anomalies (malformations and maldevelopments by defect).

Supraliminal Consciousness. —The ordinary consciousness of self; literally, the consciousness lying above the threshold; "the empiric self of common experience" as opposed to the subliminal consciousness which occasionally breaks through the same.

Supraorbital.—Above the orbit, *e.g.* the supraorbital nerve. *See* NERVES, NEURALGIA (*Trigeminal*).

Suprapubic. — Above the pubes, *e.g.* suprapubic lithotomy. *See* BLADDER, INJURIES AND DISEASES OF (*Calculus Vesicæ*, *Lithotomy*).

Suprarenal Extract. *See* ADRENAL GLANDS (*Adrenalin*).

Suprarenal Glands. *See* ADRENAL GLANDS (*Physiology*); ADRENAL GLANDS (*Adrenalin*); ADRENAL GLANDS (*Addison's Disease*); ADRENAL GLANDS (*Other Morbid Conditions*); HAY FEVER (*Treatment*, *Suprarenal Extract*); HEART, MYOCARDIUM AND ENDOCARDIUM (*General Pathology*, *Etiology*, *Chemical Causes*); HEMISINE; NOSE, LOCAL ANÆSTHETICS (*Extract of Suprarenal Gland*); PHYSIOLOGY, INTERNAL SECRETIONS (*Hormones*); PIGMENTS OF THE BODY AND EXCRETA (*Hæmoglobin and its Derivatives*, *Hæmochromogen*); POST-MORTEM METHODS (*Examination of the Body Cavities*, *Abdomen*); RICKETS (*Treatment*, *Suprarenal Extract*); TEETH (*Tooth Extraction*, *Hæmorrhage*).

Suprascapular Nerve. *See* NERVES, PERIPHERAL (*Injuries of Special Spinal Nerves*).

Supravaginal. — Above the vagina, *e.g.* supravaginal hysterectomy (removal of the uterus by abdominal incision, the cervix being left).

Sural.—Pertaining to the calf of the leg (Lat. *sura*, the calf), *e.g.* the *sural nerve*, *arteries*, and *vein*.

Suralimentation. — Forced feeding, *e.g.* in neurasthenia.

Surcingle.—The tail of the corpus striatum of the brain (Lat. *super*, above, *cingulum*, a girdle).

Surdomutitas.—Deafmutism (*q.v.*).

Surface Water. *See* WATER (*Rain*).

Surgeon. — One who practises surgery (Gr. χείρ, the hand, and ἔργειν, to work) as distinguished from medicine, or, more generally, a general practitioner; it forms part of such compound words as surgeon-accoucheur (a surgeon who practises midwifery) and surgeon-apothecary (one who has passed the examinations of the Royal College of Surgeons, England, and of the Apothecaries' Hall); in the Naval, Military, and Indian Services such titles as Surgeon, Staff-Surgeon, Fleet-Surgeon, Surgeon-Captain, Surgeon-Major, Surgeon-Lieutenant-Colonel, and Surgeon-General are now given to medical men in these services.

Surgery. — The work and art of the surgeon, especially when that is operative. There are various subdivisions into aural surgery, clinical surgery, dental surgery, military surgery, orthopædic surgery, and plastic (reparative) surgery. *See* ASEPTIC TREATMENT OF WOUNDS, and many of the articles in this *Encyclopædia and Dictionary*, such as ABDOMEN, INJURIES OF; ANKLE-JOINT, INJURIES AND DISEASES OF; BLADDER; BONE; BRAIN, SURGERY OF; etc.

Surgical.—Belonging to surgery or to a surgeon: e.g. *surgical anatomy*, or anatomy considered specially with a view to the proper performance of operations; *surgical neck of the humerus*, or that part of the bone which is thin and so more prone to fracture than the thicker part (anatomical neck).

Surmenage.—The condition of body and mind due to over-exertion, strain, or over-pressure (Fr. *surmener*, to overdrive).

Surra. *See* PARASITES (*Protozoa, Mastigophora, Trypanosoma Evansi*).

Surrogate or Surrogatum.—A drug substituted (Lat. *succedo*, I come in the place of) for another which is more expensive or less suitable; succedaneum.

Suspended Animation. *See* ASPHYXIA; CATALEPSY; etc.

Suspension.—A method of treatment in which the patient is placed in a hanging position (supported by neck, chin, and shoulders); it has been recommended in tabes dorsalis. *See* TABES DORSALIS (*Treatment, Mechanical*).

Suspensory.—Supporting or serving to suspend an injured or affected part; *e.g.* a suspensory bandage for the scrotum or breast, the suspensory ligament of the lens, etc.

Sustentaculum.—A supporting part (Lat. *sustento*, I support); *e.g.* the *sustentaculum tali* of the os calcis, for the support of the astragalus, and the *sustentaculum lienis* or phrenocolic ligament, on which the base of the spleen rests.

Susurrus.—A whispering sound heard over aneurysms, contracting muscles, etc. (Lat. *susurro*, I hum or buzz).

Sutures.—The lines along which the cranial bones fuse together in ossification, or the stitches which are used to close incisions in operative surgery. *See* ASEPTIC TREATMENT OF WOUNDS (*Disinfection of Ligatures and Sutures*); CHILDREN, CLINICAL EXAMINATION OF (*Head, Ossification*); HYDROCEPHALUS (*Morbid Anatomy*); LABOUR, PHYSIOLOGY OF (*Passenger, Fœtal Head*).

Suzanne's Gland.—A small mucous gland in the floor of the mouth.

Swallowing. *See* ALCOHOLISM (*Chronic, Symptoms, Difficulty in Swallowing*); BRAIN, AFFECTIONS OF BLOOD-VESSELS (*Paralysis from Vascular Lesions, Reflexes*); CEREBELLUM, AFFECTIONS OF (*Tumour, Symptoms, Deglutition*); DYSPHAGIA; LARYNX, ACUTE AND CHRONIC INFLAMMATIONS (*Foreign Bodies in Larynx*); ŒSOPHAGUS; PARALYSIS (*Cerebral Diplegia, Clinical Aspect*); PHYSIOLOGY, FOOD AND DIGESTION (*Swallowing*).

Swanlinbar. *See* BALNEOLOGY (*Great Britain, Ireland, Sulphur*).

Sweat Glands. *See* SKIN, ANATOMY AND PHYSIOLOGY (*Coil-Glands*); SKIN, DISEASES OF SWEAT AND SEBACEOUS GLANDS.

Sweating. *See* AORTA, THORACIC ANEURYSM (*Symptoms*); DIAPHORETICS; HEART, MYOCARDIUM AND ENDOCARDIUM (*Malignant Endocarditis, Symptoms*); HYSTERIA (*Disorders of Circulation and Trophic Disorders*); LABOUR, STAGES AND DURATION (*Second Stage, Constitutional Symptoms*); LIVER (*Tropical Abscess, Symptoms*); LUNG, TUBERCULOSIS OF (*Constitutional Symptoms, Sweating*); MALARIA (*Symptoms*); MEDIASTINUM (*Tumours, Symptoms, Unilateral Sweating*); MENINGITIS, TUBERCULOUS (*Symptoms*); PHYSIOLOGY, EXCRETION (*Excretion by the Skin*); PSORIASIS (*Sweat-Duct Psoriasis*); RHEUMATISM, ACUTE (*Symptoms*); RHEUMATISM IN CHILDREN; SKIN, ANATOMY AND PHYSIOLOGY; SKIN, DISEASES OF SWEAT AND SEBACEOUS GLANDS; SYRINGOMYELIA (*Symptoms, Paralysis of Cervical Sympathetic*); TYPHOID FEVER (*Symptoms*); UNDULANT FEVER (*Symptoms, Tegumentary System*).

Sweden. *See* BALNEOLOGY (*Norway and Sweden*).

Swedish System.—Ling's system of active and passive movements with massage used in the treatment of various diseases.

Sweet Spirit of Nitre. *See* NITRITES (*Spiritus Ætheris Nitrosi*).

Sweetbreads. *See* INVALID FEEDING (*Meats*).

Swine Erysipelas. *See* IMMUNITY (*Protective Inoculation in Swine Erysipelas*).

Swine Fever.—Hog cholera. *See* FOOD (*Unsound Food from Swine Fever Animals*).

Switzerland. *See* BALNEOLOGY (*Switzerland*); THERAPEUTICS, HEALTH RESORTS (*Switzerland*).

Sycosis. *See also* EYELIDS, AFFECTIONS OF (*Sycosis Tarsi*); X-RAYS (*Therapeutics*).—A pustular affection of the hair follicles in the region of the beard. The most frequent sites are on the chin and upper lip, but a similar inflammation may involve the whiskers and eyebrows. The earlier stages of the disease are characterised by the presence of raised shotty nodules of an acne-like character in close relation to the hair follicles, and in the later stages these appear as typical pustules with a hair passing through the centre of each. These nodules may become confluent, rendering the skin much indurated. The degree of infiltration and thickening is proportionate to the chronicity of the case. The disease is essentially chronic, and if not successfully treated tends to complete destruction of the hair sac and scar formation.

The cause of the disease is bacterial influence, probably the staphylococcus pyogenes albus and other bacteria which exist as saprophytes in the skin. The diagnosis is as a rule easy.

Impetigo contagiosa is an allied affection, which, however, is characterised by a more acute onset, more rapid development, and greater tendency to discharge and crust formation. Further, this disease is more commonly met with in early life, while sycosis is chiefly met with in adult life.

Tinea tonsurans may be mistaken for sycosis, but can readily be differentiated by a microscopical examination of the hair, which will reveal the presence of the ringworm fungus.

Impetiginous Eczema.—It is doubtful if it is wise to differentiate too closely between a sycosis and an eczema associated with reddening of the skin, and pustule formation. These conditions are probably identical in origin, and nothing is gained by attempting to differentiate them.

Treatment.—The hair should be clipped short, and the part bathed several times a day with an antiseptic lotion. Preference may be given to weak Condy's fluid, a weak corrosive sublimate, or a spray of peroxide of hydrogen. The case should then be treated by an antiseptic ointment, *e.g.* ammoniate of mercury, or sulphur. The exact composition of the ointment is of less importance than the manner in which it is applied. The inunction must be thorough, and treatment should be continued in a modified degree for months after the bulk of the disease is apparently cured. Great benefit may also be attained in not a few cases by strict attention to the general health, more especially the administration of a daily saline draught and stimulation of the function of the skin by baths. It is well to recommend the patient not to allow the beard to grow for at least six months after the disease has been apparently cured.

Sydenham's Chorea or Disease. *See* CHOREA (*Common or Sydenham's Chorea*).

Sydenham's Laudanum.—Tinctura opii crocata, or tincture of opium flavoured with saffron. *See* OPIUM.

Sydenham's Teaching. *See* MEDICINE, HISTORY OF (*Rational Empiricism*).

Sylvester's Method.—A method of carrying on artificial respiration by using the arms of the patient to compress the chest, and allowing it to expand by elastic recoil. *See* ASPHYXIA (*Resuscitation*).

Sylvian. — Named after the anatomist Jacobus Sylvius (Jacques Du Bois), who lived between 1478 and 1555; *e.g.* the *Sylvian aqueduct* (communication between the third and fourth ventricles), the *Sylvian fissure* (the fissure on the outer surface of the cerebrum, separating the parietal and frontal lobes from the temporo-sphenoidal lobe), and the *Sylvian ventricle* (in the septum lucidum). *See* BRAIN, PHYSIOLOGY OF (*Cerebral Cortex*); BRAIN, SURGERY OF (*Cerebro-cranial Topography*); HYDROCEPHALUS (*Etiology, Blockage of Aqueduct of Sylvius*).

Symbiosis.—The constant association of organisms not depending on each other for life or nourishment (Gr. *σύν*, with, and *βίος*, life); commensalism; in Bacteriology two types of microbes may attack the body at the same time and may intensify each other's attack and fail unless acting in association (*obligatory symbiosis*), or they may intensify each other's action without their alliance being essential for success (*facultative symbiosis*).

Symblepharon.—Adhesion of the eyelids to the eyeball, which may be anterior, posterior, or total. *See* CONJUNCTIVA, DISEASES OF (*Symblepharon*); EYELIDS, AFFECTIONS OF (*Symblepharon*).

Symbol. *See* PRESCRIBING (*Weights and Measures*).

Symelus or Symmelus.—A teratological type in which more or less complete

rotation and fusion of the lower limbs takes place; sympodia; the sireniform or mermaid fœtus. *See* TERATOLOGY (*Malformations of the Limbs, Sympodia*).

Syme's Amputation. *See* AMPUTATIONS (*Ankle-Joint*).

Syme's Excision of the Tongue. *See* TONGUE (*Carcinoma, Methods of Operating*).

Syme's Urethrotomy. *See* URETHRA, DISEASES OF (*Stricture, External Urethrotomy*).

Symmetrical. — Corresponding, or having its parts in due proportion; *e.g.* symmetrical lesions, symmetrical diseases, etc.

Symonds' Tube.—A metal or rubber tube for introduction through an œsophageal stricture. *See* ŒSOPHAGUS (*Fibrous Stricture, Treatment*).

Sympathetic.—Belonging to or produced by sympathy; *e.g.* the sympathetic nervous system, sympathetic insanity, sympathetic inflammation, sympathetic vomiting, etc. *See* ADRENAL GLANDS (*Addison's Disease, Pathology, Nervous Theory*); ALCOHOLISM (*Visceral, Vascular, and Trophic Variations*); AORTA, ANEURYSM AND DILATATION OF (*Symptoms, Unequal Pupils*); AUDITORY NERVE AND LABYRINTH (*Sympathetic Nerve-Deafness*); CLIMACTERIC INSANITY (*Sympathetic Insanity*); GLAUCOMA; HEART, PHYSIOLOGY OF (*Cardiac Nervous System*); PHYSIOLOGY, NEURO-MUSCULAR MECHANISM (*Spinal Nerves*, etc.); VISCERAL PAIN (*Sympathetic System*).

Sympatheticectomy.—Excision of a part of a sympathetic nerve, as in the treatment of exophthalmic goitre; sympathicotomy.

Sympathetic Ophthalmitis.

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DEFINITION. — What is termed Sympathetic Ophthalmitis is a serous or plastic inflammation of the uveal tract, excited by inflammation of a similar character in the fellow eye, the result of some perforating lesion.

The eye which has been perforated, and which is the first affected, is termed *the exciting eye*, and the other, which is subsequently involved, *the sympathising eye.*

There are cases in which inflammation of a serous or plastic type occurs in the uveal tract of an eye as the result of some constitutional disease, without any perforation of its tunics, and where later the second eye becomes similarly affected. In such cases we are unable to say whether the inflammation in the second eye was excited by that in the first, or whether, as seems more probable, both eyes became affected as the result of the same morbid constitutional state.

Nature of the Affection in the Exciting Eye.— Eyes which have received accidentally inflicted punctured wounds from some pointed instrument, or in which fragments of metal have become lodged, are the ones which most frequently excite sympathetic inflammation. Any eye, however, in which there has been a perforation, no matter how it has been occasioned, and in which a particular kind of inflammation has followed, is liable to excite a similar inflammation in its fellow.

Sympathetic ophthalmitis occasionally follows on operations such as extraction of cataract or iridectomy for glaucoma. It has been known to follow on perforating ulcers of the cornea, and on perforations of the globe caused by intra-ocular malignant growths. Eyes with a sub-conjunctival rupture of the sclerotic, and protrusion of a portion of the iris into the sub-conjunctival tissue, will sometimes become the seat of a uveitis, and excite sympathetic inflammation. It is improbable that an eye, the fibrous-tissue tunic of which has not been penetrated, can give rise to this affection.

Injuries of certain parts of the eye are more liable to be followed by sympathetic inflammation than those of others. The ciliary region is frequently spoken of as "the dangerous area." Wounds which pass into the vitreous chamber are much more likely to cause trouble than those which simply open the aqueous chamber, or which penetrate the lens without involving the vitreous humour.

A sub-conjunctival entanglement of a portion of the uveal tract in a wound is a dangerous complication. When sympathetic ophthalmitis follows on operative procedures, such entanglements are generally to be found.

As already stated, it is necessary that the perforation of the eyeball should be followed by inflammation of the uveal tract before it can give rise to sympathetic ophthalmitis. This inflammation may vary much in intensity, but it is always of a serous or plastic type. An eye with suppurative inflammation in it never excites inflammatory trouble in its fellow.

The intensity of the inflammation in the sympathising eye does not always correspond with the intensity of that in the excitor. The inflammation in the sympathising eye may be so severe as to cause its complete disorganisation, whilst that in the exciting eye is so mild as to

give rise to but slight injection, and little, if any, permanent defect of sight.

Time of Incubation.—The length of time which elapses between the receipt of an injury and the onset of inflammation in the sympathising eye is usually from four to eight weeks. That is to say, it is most liable to occur during the time at which the inflammation in the exciting eye is most acute. As the intensity of this subsides, so the risk of its transmission decreases.

Though in the large majority of cases sympathetic ophthalmitis manifests itself at the time above mentioned, it may occur either sooner or later. It has been met with as early as two weeks after the receipt of injury. On the other hand, an interval of several years has elapsed—as many as twenty in some cases.

When there has been a very long interval, careful inquiry will generally elicit a history of some fresh injury, or fresh attack of inflammation or irritability in the exciting eye, shortly before the onset of the sympathetic disease.

Natural History of Affection in the Sympathising Eye.—The onset of an attack of sympathetic ophthalmitis is sometimes, but by no means necessarily, preceded by symptoms of sympathetic irritation (*see* p. 452). Very often it begins without any premonitory warnings—mistiness of vision, floating opacities in front of the eye, or a slight amount of redness and pain being the symptoms which first attract the patient's attention.

One of the earliest changes to be found in the eye is a number of fine dotted opacities on the lower part of the posterior surface of the cornea, which are usually arranged in a little triangular area, with its apex upwards. The dots at first are often very small, and only to be detected on magnification. They are generally of a greyish colour, but some of them may be pigmented; later they tend to increase in size so as to be easily discernible with the naked eye.

The condition is commonly spoken of as "Keratitis Punctata," a name which unfortunately gives a wrong impression as to its mode of origin, for the dots are not the result of inflammation of the cornea, but are deposits on its posterior surface of inflammatory cells from the aqueous humour, thrown out by the ciliary body.

In association with dots on the back of the cornea, opacities can generally be detected in the vitreous humour, also due to effusion from the inflamed ciliary body. At first they are often only of a fine, dust-like character, producing an ill-defined haze, but may later become more pronounced. The amount of injection of the ciliary blood-vessels is at first slight, but increases in intensity as the disease progresses.

In a case seen in an early stage there will be no difficulty in obtaining a full and regular dilatation of the pupil with atropine, and in mild cases of the disease which remain throughout of the serous type, it may be possible to keep the pupil so dilated through the whole course of the attack.

When, however, as is very commonly the case, the disease assumes a plastic form, the pupil, in spite of the most energetic use of mydriatics, slowly contracts; adhesions of a firm and tenacious character form between the whole length of the posterior surface of the iris and the lens capsule, a membrane of organised inflammatory products at the same time developing in the pupil. This tendency of the pupil to contract in spite of mydriatics, forms a very characteristic symptom of iritis of sympathetic origin.

The iris becomes altered in colour. If blue, it assumes a dull greenish hue; if brown, a dull, dirty brown. Sometimes the blood-vessels of the iris may become so enlarged as to be visible to the naked eye.

In the milder cases of sympathetic ophthalmitis, from first to last the tension will remain normal. Increase of tension may occur in an early stage before the formation of any synechiæ, due in part to the difficulty which the aqueous, altered by the admixture with it of inflammatory products, has in escaping from the eye; and in part to the excess of fluid thrown into the eye by the inflamed ciliary body. More often, however, increase of tension is not met with until the later stages of the disease, when adhesions have formed between the iris and lens capsule, which obstruct the passage forwards of fluid from the vitreous into the anterior chamber.

As a final stage of all, in some of the worst cases the secretion of intra-ocular fluid becomes arrested from destruction of the secreting area of the ciliary body; the vitreous atrophies; the retina is detached, and the globe becomes soft and shrunken—the condition which is spoken of as "phthisis bulbi" being established.

The anterior chamber in the early stages of the affection, when it is of entirely a serous type, is usually deeper than normal. Later on, when extensive posterior synechiæ have formed, and there is obstruction to the passage of fluid forwards, it becomes shallowed and may be almost obliterated. Sometimes in late stages of the disease, from the organisation and contraction of inflammatory products adherent to the posterior surface of the iris, the outer margin of that structure becomes drawn back towards the circumlental space, and a deepened condition of the anterior chamber at its periphery is produced.

In sympathetic ophthalmitis, the structures at the anterior part of the eye, the iris and ciliary body, are more frequently and more extensively involved than those at the posterior part, the choroid and retina. On account of

clouding of the media, ophthalmoscopic examination of these latter structures is usually only possible in the very earliest stages of the affection.

In some cases optic neuritis or neuro-retinitis can be detected as soon as, or even before, the dots on the back of the cornea or the opacities in the vitreous humour; in others the optic disc appears to remain unchanged so long as a clear view of it can be obtained.

Microscopical examination of eyes which have been excised on account of pain in advanced stages of sympathetic disease not uncommonly show discrete patches of round-celled exudation scattered throughout the choroid, similar in character to those which are met with in the iris and ciliary body, and similar also to those which are found in exciting eyes.

The amount of pain complained of in the early stages of the disease is not usually very great. There is some tenderness over the ciliary region and some dread of light, but not much aching pain. Later on, should the iris become bound down to the lens capsule and the tension become increased the pain is often excessive, of a very distressing character, and exceedingly difficult to relieve; not uncommonly, indeed, at such a stage, excision of the eye becomes necessary and is gladly assented to by the patient, so great have been his sufferings.

Sympathetic ophthalmitis is a disease which runs a certain course and then subsides, the eye quieting down, all symptoms of redness and inflammation disappearing. The duration of an attack varies considerably; if it remains throughout of the serous type it usually lasts from three to four months. When, however, it has assumed the more severe plastic type it may continue, with occasional exacerbations, for a year or eighteen months.

Sympathetic Irritation.—It was at one time thought that sympathetic irritation was necessarily the precursor of sympathetic ophthalmitis. It is now known that though some cases of sympathetic ophthalmitis begin with symptoms of sympathetic irritation, the latter may exist for many years, and may pass off without any symptoms of inflammation supervening. Sympathetic irritation may, moreover, be excited by affections of the eye quite different from those causing sympathetic inflammation; *e.g.* it may be set up by a foreign body in the conjunctival sac.

The condition may be regarded as a neurosis, which is at once relieved by the removal of the cause of irritation in the exciting eye, of the exciting eye itself, or by division of the nerves connecting the two eyes.

The symptoms of it are photophobia; lacrymation; pains about the eye and over the brow, sometimes very severe and of a neuralgic character; slight blepharospasm; conjunctival injection; and temporary defects of vision due to inability to maintain accommodation. Some patients describe appearances like that of vapour rising before the eye.

The symptoms will sometimes subside and then recur again after an interval of variable duration.

Prognosis.—It has been repeatedly asserted that children are more subject to sympathetic ophthalmitis than adults, but statistics published with reference to this point seem to show that it has no just foundation (Gunn).

It is doubtful also if the age of the patient has any influence on the length of incubation of the sympathetic disease or on its severity. Certainly both severe and mild attacks may be met with at all ages.

As a general rule, the prognosis in sympathetic ophthalmitis appears to be more favourable when the disease comes on after a short interval than when it appears after a long one.

In the early stages a very guarded prognosis should be given as to what is likely to be the ultimate outcome of an attack, as the mildness of the symptoms at the outset are often markedly out of proportion to the grave changes which subsequently ensue.

Quite 50 per cent of eyes affected end in complete disorganisation and destruction of vision.

In some cases, where the disease remains throughout of the serous type, perfect vision may be regained on the subsidence of the attack.

The failure to keep the pupil dilated with mydriatics must always be regarded as of grave significance.

Pathogenesis. — The nature of the morbid influence in an injured eye which is capable of exciting inflammation in its fellow, and the path along which this morbid influence passes from the one eye to the other, in spite of much discussion and many experiments, still remain undecided.

The disease was originally named sympathetic ophthalmitis, because it was thought that the second eye became inflamed in sympathy with the excitor as the result of some nerve irritation in the latter. This irritation Mackenzie described as being most likely reflected along the chiasma and optic nerves.

Subsequently, when it was realised how commonly a wound in the ciliary region was the lesion in the exciting eye, and how frequently the ciliary body and iris were the parts affected in the sympathising eye, it was thought more probable that an irritating impulse travelled up the ciliary nerves of the exciting eye to the nerve centres, and was there reflected along the ciliary nerves of the opposite side to the fellow eye. The passage of a morbid influence along the ciliary nerves, such as this theory supposes, is not inconsistent with the absence of any structural changes in them. Experimental irri-

tation of the ciliary nerves in an animal's eye fails, however, to produce anything more than vascular congestion in the fellow eye — never inflammation.

The probable parasitic origin of sympathetic ophthalmitis was originally advanced by Leber. It has been suggested that micro-organisms may travel from one eye to the other, either along continuity of tissue in the lymphatics of the sheaths of the optic nerve and chiasma, or that they enter the general circulation, and the inflammation in the second eye is metastatic in character. In the latter case we should expect to meet with inflammatory changes in various situations, not only in the fellow eye, or else have to regard the uveal tract as possessing some peculiarity of structure, rendering it specially susceptible to attack.

Inflammatory changes are not met with in other parts of the body in connection with sympathetic ophthalmitis, and we have no grounds for assuming any special susceptibility of the uveal tissue. An attempt has recently been made to find this special susceptibility in the congestion caused by sympathetic irritation, but, as has been already pointed out, many cases of sympathetic inflammation begin without any signs of irritation.

Micro-organisms are undoubtedly sometimes found in eyes which have excited sympathetic inflammation, but so far no one definite micro-organism has been universally found. In some exciting eyes which have been removed and carefully examined, no micro-organisms could be detected. The inflammation in exciting eyes differs in its spreading character from that set up by mere inorganic chemical irritants, as, for example, pieces of copper or iron, or by the infliction of wounds with aseptic instruments.

So far, no micro-organisms have been discovered in the sympathising eye.

Much experimental work has been done on animals to try and prove the parasitic origin of the disease. Injections of micro-organisms into one eye have been made with the idea of trying to induce sympathetic ophthalmitis in the other.

Deutschmann has recorded some successful results which, if confirmed by others, would be of the greatest importance. Unfortunately, though a number of observers have repeated his experiments, none of them, like him, succeeded in setting up inflammation in the fellow eye.

The fact that a perforation of the tunics and the presence of a particular type of inflammation are essential in the exciting eye for starting the disease, also that a certain period of incubation is requisite before the appearance of inflammation in the sympathiser, seem strongly to point to the implantation of some phlogenetic substance in the one eye and its gradual transference to the other.

Treatment.—The most certain prophylactic treatment for sympathetic ophthalmitis is the excision of eyes with perforating lesions likely to excite it, within ten days of the receipt of the injury. The decision as to which eyes with perforating lesions it is safe to retain, and which it is necessary to remove, is in many cases easily arrived at, in others it becomes a matter of the greatest difficulty. Those lesions which are most likely to give rise to sympathetic inflammation have already been referred to.

The tendency of recent years has undoubtedly been to save many wounded eyes which would formerly have been condemned, and, coincidently with this more conservative practice, the number of cases of sympathetic inflammation which have been met with have not increased but diminished.

The decrease in the amount of sympathetic ophthalmitis, which during the last fifteen years at the Royal London Ophthalmic Hospital has been very marked, may be due in part to the more extensive use of antiseptics, both at operations and in cases with recent accidental wounds. It is probably also largely attributable to the greater care which is taken to avoid leaving any entanglements of the iris in operation wounds, and in clearing accidentally inflicted wounds as much as possible of any incarcerated portions of the uveal tract.

The ultimate prospect of the retention of useful sight in the injured eye is a most important matter to take into consideration in deciding for or against its removal. It may be worth while for a patient to run a certain amount of risk to retain an eye with useful sight, whereas it is unwise for him to run any risk of damage to the fellow eye by retaining a sightless organ.

The amount of useful sight which will result depends largely on whether or not the lens has been implicated; this point, therefore, necessarily exercises considerable influence in deciding for or against excision.

There is no risk of sympathetic ophthalmitis coming on during the first ten days after the receipt of injury, so that unless the eye has become hopelessly disorganised, it is generally well to free any portion of the uveal tract which may have become entangled in the wound, and wait a few days to see how much inflammatory reaction is likely to follow before recommending excision.

It is next important to consider what measures, if any, less radical than excision may be adopted as a prophylactic against sympathetic disease.

It was thought that if all the structures entering or emerging from the injured eyeball at its posterior part were divided, or partially removed, the transmission of any infective substance from it to the other eye would be prevented. Hence the operations of optico-ciliary neurotomy and optico-ciliary neurectomy were devised. But what appear to be undoubted

cases of sympathetic inflammation have been recorded arising months and years after the performance of these operations. Possibly a reunion of the tracks of communication occurs.

On the assumption that sympathetic inflammation is due to infecting particles travelling from a septic uveitis in the exciting eye, it was argued, that removal of the whole contents of the sclerotic, *i.e.* the operation of evisceration, before the infecting particles of the uveitis begin to travel, ought to prevent sympathetic ophthalmitis.

Several cases of sympathetic inflammation coming on after evisceration (Mules' operation) have been recorded, but so far it seems fair to assume that in all of them it had been performed too late, *i.e.* after infecting particles had passed from beyond the uveal tract.

Excision of the eye does not afford certain immunity if performed later than three or four weeks after an injury, but it probably affords a better chance of immunity at that time than evisceration, because in it the track along which the infective particles presumably travel is removed farther back.

Sympathetic inflammation having once started, should the exciting eye be excised or left? Certainly its removal sometimes seems to have no effect in mitigating the severity of the attack. On the other hand, in the rare cases where sympathetic inflammation has come on after excision, it has generally been noted that the disease has been of a very mild type.

If the exciting eye is blind or nearly blind it is usually well to give the patient whatever chance its removal may afford. If, however, it is likely that it will retain any useful sight, it may be that in the end it will be the better eye of the two, and it is wiser to retain it.

The treatment of sympathetic ophthalmitis when once it has started is much that of any other form of irido-cyclitis, heat and mydriatics being the necessary local applications.

Heat may be applied either in the form of periodic fomentations with hot lotion, or as dry heat kept up continuously by means of the Japanese hot box.

As already stated, the pupil often shows a tendency to contract in spite of mydriatics; in such cases they have to be used in their strongest forms. A two per cent ointment of atropine is the strongest that it is wise to employ, and the effect of it must be cautiously watched to see that no toxic symptoms are produced. Hyoscine is more powerful than atropine in its effect on the pupil, and may be tried should the latter show signs of failure.

No known internal medicinal treatment can be relied upon to produce any salutary effect on the disease. Some have thought they have seen improvement follow on the administration of mercury.

If, as the result of sympathetic inflammation, the pupil becomes closed with an inflammatory membrane, and the iris bound down to the lens capsule, operative measures become necessary. Whenever possible it is best to postpone any operative interference in such cases until all signs of active inflammation have quite subsided, which means, generally, until a full two years after the commencement of the attack.

Two or more separate operations are almost sure to be required before a permanent opening will be obtained through which the patient will be able to see.

In many of these cases the damage caused by the inflammatory attack is so limited to the structures at the anterior part of the eye, that if a clear opening through which light can pass is formed, a very satisfactory amount of vision is restored. The removal of the lens is necessary; this may be effected either by needling or extraction.

The formation of an opening in a tough, inflammatory, pupillary membrane, through which the lens matter may protrude, is a matter of some difficulty. It is best accomplished by Crichett's method of introducing, from opposite sides, two needles, and boring with them as with a gimlet; when they have been made to penetrate they should be separated so as to increase the size of the opening. The procedure has to be repeated from time to time until the whole lens is absorbed and a permanent clear opening obtained.

If extraction be decided on, it will usually be found that the iris is so adherent to the lens capsule that a satisfactory iridectomy cannot be performed. It is then best to make an incision across the upper part of the iris and lens capsule through which the nucleus of the lens can be removed. On some subsequent occasion an iridotomy will be required, or a puncture may be made with the point of a keratome through the iris and lens capsule, into which a hook can be inserted, so as to draw a portion of these structures out of the eye, where they can be cut off.

Symphorol. — Caffeine-sulphonic acid, which has been used as a diuretic.

Symphysiotomy or Symphyseotomy. *See* Labour, Precipitate and Prolonged (*Treatment of Labour with Contracted Pelvis*); Labour, Obstetric Operations (*Symphysiotomy*).

Symphysis.—The union or line of junction of two bones, *e.g.* the *symphysis pubis* or *symphysis menti*.

Sympiesometer.—An instrument for measuring pressure (Gr. *σύν*, with or together, and *πίεσις*, pressing).

Sympodia or Sympus.—A teratological type in which the lower limbs are more

or less completely inverted and fused together into one member; symelia; sireniform monstrosity. *See* TERATOLOGY (*Malformations of Limbs*).

Symptom.—An indication of the presence or progress of a disease, serving as a means of diagnosing the nature of the malady and the success or failure in curative measures; it is sometimes opposed to a physical sign, and is regarded as a subjective manifestation, while a physical sign is objective.

Symptom-Complex.—The group of characteristic symptoms which together make up the clinical picture of any disease; a syndrome.

Syn-.—In compound words *syn-* (Gr. σύν, with) is a prefix signifying with or along with.

Synancea. *See* SNAKE-BITES AND POISONOUS FISHES (*Poison Wounds caused by Fish*).

Synapsis.—The close relationship (without actual continuity) which the terminal processes of two neurons form with each other (Gr. σύν, with, and ἅπτω, I clasp). *See* PHYSIOLOGY, TISSUES (*Nerve, Structure*).

Synarthrosis.—An immovable joint in which there is no synovial cavity; *e.g.* sutures, synchondroses, schindyleses, and gomphoses.

Syncephalus.—A teratological type in which two fœtuses are united by the heads and thoraces; *e.g.* the various forms of Janus monster, and fused twins with a single head and two pelves and two pairs of lower limbs. *See* TERATOLOGY (*United Twins, Syncephalic*).

Synchelia or Syncheilus.—Apparent absence of the mouth or fusion of the lips (Gr. σύν, together, and χεῖλος, a lip).

Synchisis or Synchysis.—Confusion or mixing together (Gr. συγχέω, I pour together); *e.g.* synchisis scintillans, the appearance of falling particles due to the presence of cholesterine crystals in the vitreous humour of the eye. *See* VITREOUS HUMOUR, DISEASES OF (*Degeneration*).

Synchondrosis. *See* SYNARTHROSIS.

Synchondrotomy.—The section of the intra-articular cartilage of such a joint as the symphysis pubis; symphysiotomy (*q.v.*).

Synclitism.—Parallelism between the planes of the fœtal head and those of the mother's pelvis in labour; synclitic descent is downward progress of the fœtal head, certain planes of which maintain their parallelism with the successive planes of the pelvis; it is doubtful whether synclitism normally occurs in labour.

Synclonus.—Tremor occurring simultaneously in several muscles, *e.g.* in chorea.

Syncopal. *See* SYNCOPE.

Syncope. *See also* CATHETERS, USES AND DANGERS OF (*Syncope*); DIPHTHERIA (*Complications*); HEART, MYOCARDIUM AND ENDOCARDIUM (*Etiology, Gouty Syncope*); HEART, MYOCARDIUM AND ENDOCARDIUM (*Effects of Cardiac Disease, Sudden Death*); HEART, NEUROSES OF (*Bradycardia*); HYSTERIA (*Disorders of Circulation*); LUNG, TUBERCULOSIS OF (*Progress, Terminations*); MALARIA (*Syncopal Form*); MALINGERING (*Circulatory*); PLEURA, DISEASES OF (*Pleurisy, Prognosis, Sudden Death*); PLEURA, SURGICAL AFFECTIONS OF (*Empyema*); RAYNAUD'S DISEASE (*Symptoms, Local Syncope*); SHOCK; STOMACH AND DUODENUM, DISEASES OF (*General Symptomatology, Syncope*); UNCONSCIOUSNESS.—Syncope or fainting is a symptom seen in many different diseases, and may be induced by conditions differing widely one from another. No matter, however, what be the indirect or predisposing causal factor, the direct cause is essentially cerebral anæmia. The usual signs and symptoms of syncope are pallor of the face, cold sweat on the brow, clamminess of the hands, a sensation of sinking, nausea, and often of giddiness, blurring of vision, or a sensation of darkness, loss of consciousness, and, if the patient be in the erect posture, a somewhat gradual and passive sinking of the body towards the horizontal position rather than an actual sudden fall. The patient then remains unconscious for a variable period of time, during which the cardiac activity is so feeble that the radial pulse and cardiac impulse are imperceptible, although the heart's action is probably, almost certainly, not altogether in abeyance. During this period the respiratory movements are feeble and shallow. The attack passes off gradually, and consciousness is, as a rule, regained with one or more sighing respirations.

Syncope is of more frequent occurrence in the female than in the male sex. Many women are, it is almost unnecessary to state, subject to frequent fainting attacks. In these instances of ordinary fainting, the event is, as a rule, brought on by some emotional disturbance—fright, horror, grief, pain, sudden joy, and so forth—or by the individual being in an overheated or overcrowded apartment or building. In cases of this nature, there is a primary dilatation of the cutaneous and intra-abdominal blood-vessels with consequent fall of blood pressure, cardiac weakness, and cerebral anæmia. Syncope is further a not infrequent symptom of cardiac disease, being more common in association with aortic than with mitral lesions, and the patients who are liable to syncopal attacks usually complain of headache, and of giddiness and faintness, when they rise suddenly from the recumbent posture. In cases of myocardial disease, whether associated with valvular lesions or not, in cases of aortic aneurysm, of cardiac

strain, and of gouty heart, a tendency to syncope and actual fainting are not uncommon. In cases of bradycardia there may be syncopal attacks. The cases of this nature have, as a rule, been in persons of advanced years affected with marked arteriosclerosis, whilst in some of these cases the syncopal attacks have been replaced by attacks of vertigo or by epileptiform seizures. Syncope is also liable to occur in cases of anæmia, as in chlorosis and in the anæmia resulting from hæmorrhage, further in persons suffering from organic brain affections and chronic renal disease, and may be one of the immediate effects of pneumothorax or of the rapid withdrawal of a large pleural effusion. Fatal syncope is seen in diphtheria, most commonly during the convalescence of the patient, and in croupous pneumonia, being in both these latter instances usually brought on by some muscular effort, as, for example, when the patient attempts to sit up in bed.

In the diagnosis of syncope, one must be careful not to mistake an epileptic seizure for a fainting attack. Error can hardly arise in the case of a typical attack of grand mal. In the milder and atypical forms of epilepsy there is more difficulty, especially when one is dealing with girls and women. The biting of the tongue, the occurrence of the attack during sleep, the involuntary passage of urine, and the full bounding pulse during seizure, are some of the points which serve to distinguish epilepsy from syncope.

Syncope very rarely leads to a fatal issue unless the individual be suffering from some serious disease such as fatty heart, aortic incompetence, renal disease, or pneumonia.

Treatment.—The main object of treatment being to promote the passage of blood to the brain, the patient's body should be at once brought into the horizontal position and the head kept low, lower if possible than the rest of the body, whilst the feet and legs may at the same time be elevated. The loosening of any tight clothing about the chest is also indicated. To induce contraction of the cutaneous blood-vessels friction should be applied to the limbs, and the patient should obtain plenty fresh cool air, the heart's action being stimulated by the inhalation of ammonia and by throwing cold water upon the face. If these measures fail to restore consciousness, sinapisms should be applied to the precordia, the extremities bandaged, and some cardiac stimulant injected hypodermically. It is seldom necessary to resort to transfusion or to artificial respiration. After the patient has regained consciousness, it is advisable that the recumbent position be maintained for some time, and a little stimulant may be given by the mouth, unless there be reason to suspect hæmorrhage.

Syncytiolysin.—A material believed to be developed in the maternal blood, which renders innocuous a poison (syncytiotoxin) produced by the fœtal tissues during pregnancy, but if found in excess causes eclampsia. *See* Eclampsia, Recent Theories (*Placental Origin*).

Syncytioma.—A tumour composed of syncytial (plasmodial) elements; deciduoma or chorioma malignum or chorion epithelioma.

Syncytium.—The epithelium which covers the villi of the chorion in the young placenta; it shows no cell outlines, and is a plasmodium with many nuclei. *See* Pregnancy, Pathology of, Ovum and Decidua (*Affections of Chorion*).

Syndactyly or Syndactylism.—Adhesion of the fingers or toes to each other; webbing of the digits. *See* Deformities (*Hands and Fingers, Webbed*); Deformities (*Toes, Syndactylism*).

Syndesmitis.—Inflammation of a ligament (Gr. σύν, with, and δεσμός, a band).

Syndesmotomy.—Division of a ligament; Parker's operation.

Syndrome.—A symptom-complex or group of symptoms constituting the typical clinical picture of any disease (Gr. σύν, with, and δρόμος, a running), e.g. *Potain's syndrome* (*q.v.*).

Synechia.—A pathological union of neighbouring parts, *e.g.* of the pericardium, or of the iris to the cornea or to the capsule of the lens; *synechotomy* is the division of such a union.

Synergy.—The correlation of functional activity between different organs, healthy or diseased.

Syngenesis.—Reproduction by means of two sexual elements (ovum and spermatozoon); the theory that the embryo contains the germs of all future generations.

Synkinesis.—A movement of one (paralysed) part of the body occurring at the same time as that of another (non-paralysed) part and as the result of it, the former movement being involuntary and the latter voluntary or reflex.

Synocha or Synochus.—A continued fever (Gr. συνοχή, a holding together).

Synopsia or Synophthalmia.—Fusion (complete or incomplete) of the two eyes; cyclopia (*q.v.*).

Synorchism or Synorchidy.—Fusion, more or less complete, of the two testicles.

Synostosis or Synosteosis.—Union or ankylosis of bones which are normally separated. *See* Joints, Diseases of (*Impaired Mobility, Bony Ankylosis*).

Synotia or Synotus.—A teratological type in which the external ears are approximated and more or less united in the median line; it is associated with *cyclopia* and with absence of the lower jaw (*agnathus*). *See* TERATOLOGY (*Face*).

Synovitis.—Inflammation of a synovial membrane. *See* ANKLE-JOINT, REGION OF, DISEASES (*Synovitis*); FLUIDS, EXAMINATION OF PATHOLOGICAL (*Synovial Fluid*); GONORRHŒAL INFECTION (*Synovitis in Women*); JOINTS, DISEASES OF (*Definition, Pyogenic, Tuberculous, Syphilitic*); KNEE-JOINT, DISEASES OF (*Pyogenic Diseases*); SYPHILIS (*Secondary, Tertiary*); URETHRA, DISEASES OF (*Gonorrhœa, Complications*).

Synteresis.—Preventive or prophylactic treatment (Gr. συντηρέω, I watch closely).

Syphilide.—A cutaneous manifestation of syphilis; a syphiloderm. *See* SYPHILIS.

Syphilido-.—In compound words *syphilido-* means belonging to or related to syphilis; e.g. *syphilidography, syphilidophobia, syphilidophthalmia*, etc.

Syphilis.

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Historical.—The history of syphilis has been investigated more thoroughly than that of any other affection. Its earlier records are obscure, and for all practical purposes it appeared as a new disease in Europe in 1494, though it had long been recognised in the New World, and there is but little doubt that the Spaniards who sailed with Columbus in his first voyage became infected, and thus introduced it into the Old World at a most convenient opportunity for its wide distribution. Vigo (1460-1517?), writing as a contemporary, says: "In the month of December, when Charles the French King took his journey into the parts of Italy to recover the kingdom of Naples, there appeared a certain disease throughout all Italy of an unknown character, which sundry nations hath called by sundry names. The Frenchmen call it the disease of Naples, because the soldiers brought it from thence into France. The Neapolitans call it the French disease, for it appeared first when they came to Naples." In the end it became known as Morbus Gallicus, which the common people shortened to Morbus. In its first appearance it was epidemic, and as neither the mode of infection nor the method of cure was recognised, it spread with such rapidity that on the 21st April 1497 the Town Council of Aberdeen issued the following order: "The said day it was statut and ordanit be the Alderman and Consale (Council) for the eschewin of the infirmitey cumm out of Franche and strange partis, that all licht wemen be chargit and ordanit to decist fra thar vices and syne of venerie and all thar buthes and housis skalit, and thai to pass and wirk for thar sustentacioun, under the payne of ane key of het yrne one thair cheekis and banysene of the toune." Mr. Alexander Duncan, who quotes this edict, points out that it has an interest apart from its being the earliest notice of the presence of syphilis in Scotland, because before 1500 no medical writer on the subject had even hinted that it had any connection with the "syne of venerie." Yet, here in this northern Scottish burgh, the astute municipal authorities had anticipated conclusions subsequently come to by the faculty. In Scotland, too, syphilis was known as "Glengore" or "Granggore," a word corrupted from the French Grandgore, *à la grande gorre*, the local name for the disease at Rouen, as we learn from Rabelais (*Pantagruel*, v. xxi.). Six months after the Aberdeen edict the Scottish Privy Council issued the "Grangore Act," which ordered all the inhabitants of Edinburgh affected with the disease to pass out of the town and to appear upon the sands of Leith on a stated day and hour, thence to be conveyed by boat to the island of Inchkeith. The earliest entry referring to the

disease in Glasgow occurs in the accounts of the Lord High Treasurer of Scotland (1497-98), where the following payment was made by the King (James IV.): "*Item*, the xxii day of Februar giffen to the seke folk in the grangore at the toun end of Glasgo . . . ii sol."

The now familiar name of Syphilis was given to the disease, or at any rate was rendered familiar, by the widely read poem *Syphilis, sive Morbus Gallicus*, written by Jerome Fracastoro, who was born at Verona about 1483.[1] It is remarkable that partly owing to the existence of a different canon of morality, and partly to the fact that at first syphilis was contracted extra-genitally in many cases, no great moral turpitude attached to the disease; thus Benvenuto Cellini, the Florentine goldsmith (1500-1570), says that "in Rome this kind of illness is very partial to the priests, and especially the richest of them." He tells us that it was treated in the native American manner with guaiacum, and that the methods of fumigation and inunction with mercury were originally employed at Rome by Giacomo Berengario da Carpi. The first outbreak was very severe, as is usual when a disease attacks an unprotected population, but the symptoms became milder when it had lasted a few years, though there were occasional outbreaks of a more severe type.

Distribution.—No country and no people are exempt from syphilis. It is most common where opportunities for promiscuous intercourse are most abundant or are most readily tolerated, as in large towns and where the pioneers of a more highly civilised race are brought into contact with people in a lower state of culture. It is rarely seen in the country districts of Europe, where each knows his neighbour, for, with ordinary precautions, infection is always due to direct contact, so that any syphilitic individual has only a limited power of spreading the disease.

The more benign forms of syphilis are seen in those leading healthy lives, whilst its worst ravages occur in those whose health is undermined by alcoholic excess, sexual debauchery, or unhealthy surroundings. And yet, though this is the rule, there is no question that certain people are much more severely affected by syphilis than others, for in this as in every other disease the susceptibility of the individual patient must be taken into account.

General Pathology.—The general character of syphilitic manifestations is that of a chronic inflammation, which in its more pure forms shows but little tendency to suppurate. The cause of the disease is still unknown.[1] Many observers have described various micro-organisms which they have believed to be specific, but it has not yet been found possible to produce the disease either by inoculation with these organisms or by the toxins which they manufacture. It is remarkable, too, that syphilis cannot be inoculated upon animals, even the higher primates, yet no human being appears to be immune, from earliest infancy to extreme old age, unless he has been protected by a previous attack.

Syphilis consists microscopically of numbers of small, round cells, some of which are derived from the connective tissue, whilst others are immigrant leucocytes. These cellular infiltrations show a singular tendency to undergo resolution in the earlier stages of the disease; whilst in the secondary and tertiary stages they develop into a low form of fibrous tissue-scar or fibroid tissue—or the individual cells may coalesce to form giant cells, whilst others undergo fatty and hyaline change. This infiltration of round cells is especially liable to occur in the perivascular lymphatics and in the neuroglia of the central nervous system. The syphilitic poison bears a direct relation to these cells in some way which is not yet known, though it is probable that they manufacture it when an infinitesimal amount has once been introduced into an unprotected body.

The characteristic inflammation of the later stages of syphilis is known as a gumma, the word being derived apparently from a simile adopted by Fracastoro in his poem on Syphilis when he wrote *mox in lentum durescere gummi*. The gumma in its typical form is a whitish or yellowish-white globular mass, which varies in size from a small pea to a walnut as it is seen with the naked eye. It is often circumscribed, but never encapsuled; it may invade the neighbouring tissues, and is surrounded by an inflamed zone, though no vessels penetrate the gumma itself. The tissue is sometimes tough and leathery in consistence, at other times it is soft and pulpy. It grows with varying rapidity, and with all the symptoms of an inflammatory swelling. Like all other syphilitic lesions, a gumma may disappear completely, but when it suppurates and can discharge on the surface of the body, it leaves a perfectly circular, crater-like ulcer with a sloughy base and an undermined edge. In these cases repair is slow,—unless anti-syphilitic remedies are given,—and a depressed scar is produced.

Modes of Infection.—The primary syphilitic lesion, whether it be a hard sore or merely an erosion, is acutely contagious; in the secondary stage syphilitic lesions of the skin and mucous membranes are very infectious, the mucous patches and condylomata seeming to be more

[1] The first mention of the word occurs in the following lines:—

Syphilus (ut fama est) ipsa hæc ad flumina pastor
Mille boves, niveas mille hæc per pabula regi
Alcithoo pascebat oves.

(The story runs that Syphilus, a herdsman, tended by these streams a thousand oxen, and in these meads fed a thousand snow-white sheep, all belonging to King Alcithous.)

[1] See page 486.

liable to spread the disease than the papules and tubercles. Both in the primary and secondary stages the blood is capable of transmitting syphilis, and the lymph seems to have a similar power, though its action in this respect is less certainly known. It is not known either whether the tertiary manifestations of the disease are infective, though it seems probable that the earlier lesions are dangerous, whilst the later ones are inert. Infants with syphilis, whilst they have mucous patches and condylomata, are as capable of infecting others as those who have acquired the disease later in life, but infants with hereditary syphilis seem to be less capable of transmitting the disease than those who have acquired the disease just after birth. So far as is known at present, the syphilitic poison can only be inoculated by the transference of diseased cells or the débris of cells from the affected person to an abraded surface on the recipient, and the inoculation of a fluid free from cells or containing only healthy cells is insufficient to produce the disease. The urine, milk, and sweat, therefore, are innocuous unless the glands from which they are derived are actually syphilitic, but the saliva may transmit the disease, because the mouth is so often the seat of mucous patches. This statement, however, finds an exception in the semen, which may be inoculated with impunity, though it has the power of transmitting syphilis to the ovum it fertilises.

Syphilis can only be caused by inoculation with the syphilitic poison obtained from a pre-existing case of syphilis, but the poison is of great potency, and has some power of withstanding external influences. It is usually acquired during sexual intercourse, and the seat of inoculation therefore in about 90 per cent of the cases is at, or near, the genital organs. Indeed, the overwhelming proportion of cases of syphilis due to venereal infection has somewhat masked the fact that syphilis, from a pathological standpoint, is a chronic infective granuloma starting from a local lesion, the disease being one which in all probability must be classed between leprosy and cancer.

Inoculation with the syphilitic virus at any point is always successful in an unprotected person, and may lead to the disease in all its forms. It is not uncommon, therefore, for persons to contract syphilis accidentally and without venereal intercourse. Syphilis obtained in this manner is sometimes called "Syphilis insontium" or "Syphilis of the innocent," a thoroughly unscientific expression, for ethics have no place in pathology. Women, from their habit of kissing babies and casual acquaintances; surgeons, accoucheurs and midwives, from the nature of their occupation, are specially liable to contract syphilis. Certain occupations have been fruitful in the spread of syphilis, notably glass-blowing, where the blowing-tube is passed from mouth to mouth. Outbreaks of syphilis have been traced to arm-to-arm vaccination, and some years ago I saw several Jewish children who had been inoculated during the performance of ritual circumcision.

Dr. Bulkley, who has paid special attention to these unusual sources of infection, states that in extra-venereal syphilis, chancres of the lip are much the most numerous, the principal cause for the sore in this situation being kissing. Chancres of the breast and nipple, which come next in frequency, are becoming relatively rare, as the danger from syphilitic nurslings is better known and appreciated. It is interesting, too, to note that in the reports of 9058 cases of extra-genital chancres, collected by Dr. Bulkley, 571 cases occurred on the tonsils, in addition to 734 cases where the primary lesion was said vaguely to have been "in the buccal cavity," whilst 199 occurred on the tongue and gums, making no less than 1504 cases of primary syphilis within the cavity of the mouth. These statistics show that it is often worth while to inquire about the history of a sore mouth in the numerous cases where it is not found possible to elicit any recollection of venereal trouble.

The resistance of the syphilitic poison to external influences is shown by the fact that there are many authentic instances of the disease being communicated by contaminated pipes, cups, spoons, forks, towels, sponges, and articles of underclothing, as well as by unclean surgical and dental instruments, and by razors. The risk of infection with syphilis is so real, and people affected with the disease are so careless and so ignorant (for they often believe that they can only infect by sexual intercourse), that every individual should be warned of his liability to spread the disease, and should be definitely instructed in the precautions necessary to prevent him from so doing.

Classification.—Syphilis is either acquired or inherited. Acquired syphilis is always due to direct inoculation, the seat of inoculation being marked by a local inflammation known as a sore or chancre. Hereditary syphilis is divided somewhat academically into "congenital syphilis," where the infant is affected with syphilis contracted by the mother during pregnancy; and "inherited syphilis," where the disease begins at the time of conception, either from a syphilitic ovum or from contaminated spermatozoa.

Acquired Syphilis

In acquired syphilis there is a definite inoculation followed by a period of incubation before the appearance of the first sign of the disease. This sign, the primary sore, which runs a definite course, if it be protected from injury, is followed by certain additional signs which constitute the stage of secondary syphilis. The

secondary symptoms always follow inoculation with syphilis, though they may be readily overlooked in slight cases, and they usually, but not always under appropriate treatment, give place to a further sequence of chronic inflammatory changes which together make up the tertiary stage of the disease. This division of syphilis into primary, secondary, and tertiary stages was first adopted by Philippe Ricord (1800-1889). It is convenient for descriptive and therapeutic purposes, but it has no claim to scientific accuracy, and it is not clinically correct, for, as in all other infective diseases, the signs and symptoms of the various stages are often coexistent, and thus blend insensibly one with another.

Inoculation.—The inoculation of syphilis, so far as is known at present, can only take place upon a surface deprived of its surface epithelium in such a manner as to expose the intra-epithelial lymphatic system.

When the culture is pure the abrasion heals readily, and for some time there is nothing to alarm the patient or make him suspect that he has contracted so far-reaching a disease. More frequently, however, the inoculation has been a mixed culture containing various pyogenic organisms (*see* article Venereal Disease), and the abrasion becomes an ulcer.

Primary Syphilis.—Inoculation is followed by an incubation period of varying duration, which ends in the first local manifestation of syphilis or the primary sore. Countless observations have been made as to the duration of this incubation period, partly by clinical observation and partly by the experimental inoculation of syphilitic poison. The mean of these observations, so far as they have been tabulated, gives twenty-five days as the incubation period. This mean, however, is insufficient for practical purposes, and I am in the habit of telling my patients that they must not consider themselves safe until after the expiration of forty days from the date of exposure to infection.

The initial manifestation of syphilis varies greatly in appearance. It may be a mere erosion of the surface, it may be a dry papule, or it may be a chancre with an indurated base as in the classical form described by John Hunter, but more often so slightly indurated that it requires some skill as well as experience to distinguish it from a soft sore.

The initial manifestation of syphilis is usually single, but too much importance must not be laid upon this point in distinguishing syphilis from other forms of venereal disease, because syphilis may be inoculated simultaneously, either at two or more adjacent parts or at several places in the same body widely separated from each other.

The situation of the venereal chancre in the male is usually on the inner side of the foreskin or in the sulcus of the glans penis. The frænum, the orifice of the foreskin when the prepuce is long and tight, the glans and the meatus as well as the skin of the penis, are often the seat of the sore, whilst the scrotum and anus are not exempt. Chancres of the urethra occur either in the fossa navicularis or at some little distance from the meatus. They are important because the patient may be ignorant of their existence, and attribute his discomfort to an attack of gonorrhœa.

The female genitals are said to be liable to infection in the following order: the labia majora, the labia minora, the fourchette, the cervix uteri, the region of the clitoris, the vestibule of the vagina, the urinary meatus, the upper commissure of the vulva and the vagina. The induration is usually less marked in women than in men, and the initial lesion is often so slight that it passes unnoticed or is looked upon as a simple erosion.

The primary sore disappears spontaneously in syphilis, if it be kept clean and free from injury. Its duration, however, varies greatly, though it has usually disappeared by the time the secondary symptoms have become well marked.

Pathology of the Sore.—The first indication of syphilis is commonly a superficial erosion situated on the internal surface of the prepuce in men, and on the inner side of the labia minora in women. The erosion begins as a dry and slightly raised reddish spot, which soon begins to desquamate but is not painful. The spot is circular at first, but it soon becomes irregular owing to ulceration. The surface of the ulcer is bright coloured, smooth and flat, or very slightly excavated. The discharge is serous and scanty if the ulcer is protected, but it becomes purulent even if it be only slightly irritated. The induration is slight and superficial. Cicatrisation is rapid, and a slightly indurated scar is left, which eventually disappears entirely.

The Hunterian chancre or classical "hard sore" first appears as an indurated nodule, the surface of which soon ulcerates as a result of irritation. The edges of the chancre are raised and rounded, and the surface is smooth and covered with a little viscid secretion. In a typical case, when the nodule is pinched up between the finger and thumb, it feels as hard and inelastic as a mass of cartilage; often, however, the induration is more extensive but less well defined, and the lesion is then called the parchment sore. The hard sore is seen most often in the coronary sulcus of the penis near the frænum, and on the labia majora in women: the parchment sore is more common on the skin of the penis, and in the vulva. Little by little granulations appear, and the sore heals by cicatrisation to form a scar which is often pigmented, or it may remain as a fibrous nodule perceptible for many years.

The mixed chancre is one in which syphilis

has been acquired at the same time as a soft sore (*see* art. Venereal Disease), and it is by no means an infrequent lesion. The soft sore runs its usual course as an ulcer, secreting pus until about the third week, when the ulcer begins to look less deep, whilst the secretion diminishes in quantity and becomes thinner and more viscid. The floor of the ulcer loses its irregular appearance and becomes flatter, whilst the edges are no longer undermined. This lessening in the depth and circumference of the ulcer is due to the development of an induration beneath it and around it, for such a sore can readily be raised from the underlying tissue, and feels of gristly hardness if it be pinched up between the finger and thumb. If the ulcer be kept clean its surface becomes smooth and glistening, the discharge gradually diminishes, and scarring takes place, often without any diminution of the induration. The induration usually disappears after a longer or shorter period, but it may persist owing to the conversion of the inflammatory tissue into scar tissue.

The indurated or sclerotic œdema is a rarer form of initial lesion, which is found in women on the labium majus, and in men as an infecting balanitis. The condition is due to a slow and painless swelling of the part involved until the labium or the prepuce is uniformly thickened and indurated.

The dry scaling papule is another rare form of primary lesion which has been most often seen as a result of experimental inoculation with syphilis when care has been taken to keep the part free from irritation. A sharply defined papule appears at the seat of inoculation at the end of the incubation period. It is dark or reddish brown in colour, round or oval in shape, and elastic in consistence. The induration is slight, it does not ulcerate, and gradually subsides, leaving a slight violet-coloured or brown spot without any cicatrix.

The silvery spot has been described by Dr. Robert W. Taylor of New York as a very unusual initial manifestation of syphilis. He says that it generally occurs on the glans and on the lips of the meatus, and at first it looks as if a spot of mucous membrane no larger than a pin's head had been touched with carbolic acid or with nitrate of silver. This peculiar staining of the superficial epithelial cells is alone evident even when the tissue is closely examined with a magnifying glass. The silvery lesion increases slowly but visibly day by day, and preserves its integrity of surface, whilst its base becomes more and more indurated until it reaches a maximum, when it gradually disappears, giving place to a smooth shiny surface like that of the chancrous erosion.

Any form of hard chancre may become gangrenous, may slough, or may be attacked by phagedæna in unhealthy or uncleanly persons.

The appearance of a hard sore is always followed in a week or ten days by an enlargement of the neighbouring lymphatic glands, and this infection of the lymphatic system is often a valuable help in diagnosis, for it shows that the disease is no longer local. In genital chancres the inguinal glands on the affected side are first affected, but the inflammatory condition soon spreads to the opposite side; in extra-genital chancres the lymphatic gland physiologically nearest the seat of inoculation is the first to become enlarged. The enlargement of the glands has to be inquired for and felt, because there are no symptoms of inflammation, and the patient is often ignorant of its occurrence. In simple cases the enlarged glands remain freely movable both upon themselves and beneath the skin, and one gland of a group is often larger than the rest, but if the chancre is suppurating they are readily converted into abscesses.

Many observers have studied the microscopic appearances of a hard sore, and have shown that the characteristic induration is due to a proliferation of small round cells which occupy the interstices of the true skin beneath and around the seat of inoculation, whilst in some places the deeper layers of the epithelium itself are invaded. Some of the cells, as might be expected, when they are so numerous and compact, undergo degenerative changes similar to those seen in the gummata developed at a later stage of the disease (p. 472). The blood-vessels, both arteries and veins, surrounding the chancre, as well as those at some distance away, are affected uniformly and at a very early stage of the inflammation, for the endothelial cells are swollen and proliferating, whilst the walls are infiltrated with the small round cells always found in syphilitic inflammations. The perivascular lymphatics soon become crowded with similar round cells, whilst the lymphatic vessels themselves are enlarged and thickened.

It appears, therefore, that the initial inflammatory lesion of syphilis spreads along the lymphatic spaces in the outer coats of the blood-vessels — the perivascular lymphatics— until the nearest lymphatic glands are reached, and from these glands the inflammation spreads to other glands more remote from the seat of inoculation. The general glandular enlargement, however, is evidence of constitutional infection, and is not the result of inflammation spreading from one chain of lymphatics to another.

Treatment of Primary Syphilis.—It is probable that in the case of syphilis, as in all other inoculable diseases, the virus takes some short time to enter the tissues, and that if any abrasion or sore could be disinfected shortly after inoculation, the further spread of the disease would be arrested. The circumstances under which syphilis is contracted, whether genitally or extra-genitally, are prohibitive of such disinfection, unless perhaps in the case of

a surgeon or midwife knowingly inoculated in the course of their duties. Excision, cauterisation, and even the most careful disinfection are useless when the primary sore has become manifest, for analogy with all other infective diseases shows that the initial manifestation is only evidence of general infection. Yet the fears of patients have led to divers experiments in the way of local removal, but without any definite satisfactory results.

The treatment of primary syphilis, therefore, resolves itself into treatment of the chancre, and constitutional treatment of the disease of which the chancre is the local indication. The simplest means are usually sufficient to cure the chancre, which has indeed a tendency to undergo spontaneous resolution if it be not irritated and if it be kept clean. The sore in its simpler forms should be gently washed night and morning with warm boric lotion, a piece of dry gauze or lint being laid over it in the intervals to protect it from injury and to absorb any slight serous discharge which may be produced. More active measures must be taken when suppuration occurs, the bathing should be more frequent, and a lotion of 1 in 2000 biniodide of mercury may be substituted for the boric lotion. Many patients have a distinct objection to the use of iodoform, chiefly on account of its smell when it is carelessly applied; but it is often a most excellent application, and if care be taken not to spill it over the clothes it can be used with a minimum of discomfort. Black wash and lotio plumbi are also very serviceable applications whose advantages have withstood the test of time.

There is great diversity of opinion as to the proper treatment to be adopted constitutionally about the time of the appearance of a sore. Every one is agreed that mercury should be given as soon as syphilis is recognised, for mercury is the antidote to syphilis, and the induration of a hard sore disappears more rapidly when mercury is administered than when it is withheld. Every one, however, is equally agreed that the first and most important question to decide is that which is the most difficult in the majority of cases, viz.: "Is this patient suffering from syphilis, or is the sore which he presents due to some local inflammation?" The greater his experience the more does a practitioner recognise the many pitfalls which beset the diagnosis of syphilis in its earliest stages, and the more reluctant is he to pronounce a definite opinion in the many doubtful cases which come under his observation. It has become a rule, therefore, to adopt a temporising policy, and not to give the patient mercury until there is unequivocal evidence that he has really contracted syphilis. This appears to be a satisfactory plan to pursue until the diagnosis of syphilis is founded on some scientific basis, for at present it rests merely on clinical evidence. Mercurial treatment, to be of any service, requires a very prolonged course and a clear understanding of the principles involved both on the part of the surgeon and the patient. It is a waste of time and money to carry it out on a patient who has not syphilis, whilst if he has syphilis, and he knows it, he is the more likely to carry out the treatment in its integrity than if he has the lingering hope that after all he had only an inflamed soft sore. The constitutional treatment of primary syphilis consists, therefore, in the administration of mercury as soon as the evidence of syphilitic infection is irrefragable. Until this is established the patient should be given some tonic which may bring him into the best possible condition of health, with a view to the long and depressing period of treatment which is before him.

Secondary Syphilis.—The appearance of the primary sore is followed after a varying period by further and more generalised symptoms, which show that the syphilitic poison has increased within the body, and is now affecting the entire system. The secondary symptoms, as they are called, follow the initial manifestation in nearly every case. Sometimes they are so slight as to be entirely overlooked, both by the surgeon and by the patient, but in a few cases where the patient has been kept under the observation of reliable and experienced practitioners the secondary symptoms have not occurred. Indeed, there is some tendency to divide the various stages of syphilis by lines which are too hard and fast, in accordance with Ricord's classification, into primary, secondary, and tertiary syphilis. Nature rarely works by abrupt divisions, and in syphilis, as in all other diseases, the symptoms of one stage merge into and often coexist with those of another. It may be stated, with these reservations, that the secondary symptoms of syphilis occur about six weeks after the appearance of the initial manifestation, and that the secondary stage lasts from one to two years.

The patient often presents no symptoms of constitutional infection for some time after the appearance of the initial lesion, though a careful examination will show that the lymphatic glands are becoming enlarged in various parts of the body. The glands do not attain any great size, they show no tendency to suppurate, and they are freely movable in the surrounding tissues and upon each other. They do not usually cause any pain or discomfort, so that they may pass entirely unnoticed by the patient, even when their outline is clearly visible to the eye of a trained observer. The chain of glands at the posterior border of the sternomastoid muscles—the *glandulæ concatenatæ*—the posterior occipital glands, and those behind the ears, are most commonly enlarged and are most easily felt. The epitrochlear glands, situated two or three fingers' breadth above the internal con-

dyle of the humerus, are said to be so uniformly enlarged in syphilis as to be almost pathognomonic if the more ordinary causes can be excluded. The epitrochlear gland is examined by bending the patient's elbow, slightly adducting his arm, and placing the hand outside his arm so that the fingers are inserted into the groove between the biceps and the triceps. The enlargement is not limited to the superficial glands, for the prevertebral, lumbar, iliac, and femoral glands are often affected, the mesenteric glands being more rarely involved. This glandular enlargement is wholly independent of any skin or visceral lesion. It remains for an indefinite period, though the glands generally diminish in size when mercury is administered, and the number and position of the glands involved vary in every individual.

The patient often presents certain symptoms of malaise in the interval between the appearance of the sore and the secondary symptoms, which can only be considered as evidence of a progressive absorption of the syphilitic poison by the various tissues of the body. These symptoms are often so slight as to constitute little more than a malaise, which might be attributed to the popular dread of the disease if similar symptoms did not occur during the prodromal period of tetanus and hydrophobia, where we know that toxins are being produced in an infected body. The patient complains of a sense of general discomfort, with weakness, lassitude, and disinclination to follow his usual occupations; he may be sleepless, and his appetite fails; his complexion becomes sallow, his skin is pale and dry, and his eyes are dull and heavy-looking. He has "rheumatic" pains in his bones and joints, which are worse at night, and he suffers from neuralgia of the face and scalp, or even of the intercostal and sciatic nerves. The painful joints are sometimes a little swollen by a serous synovitis. These vague symptoms may culminate in a sharp attack of fever, which precedes by a few days the first decided sign of secondary syphilis.

The fever which ushers in the secondary manifestations of syphilis is often considerable, for the temperature may rise to 104° F., being high at night and falling nearly to normal in the morning. It rarely lasts more than three or four days, and it is occasionally distinctly remittent in character. There is a corresponding quickening of the pulse, and the respiratory rhythm is accelerated. A faint blush may appear at different parts of the trunk whilst the patient is still feverish, but the blush disappears and the temperature falls in many cases as soon as the first rash becomes visible.

A remarkable peculiarity of the syphilitic poison is the readiness with which it attacks points of least resistance in each body in much the same manner as does influenza. The full force of the syphilitic inflammation is felt by different tissues in different individuals: thus in one the mucous membranes suffer most; in another the fibrous tissues, so that the bones, joints, and blood-vessels are unduly affected; whilst in another the nervous system, and in yet another the viscera, are more particularly attacked. It is not surprising, therefore, to find that a typhoidal condition, a temporary inflammation of the kidneys, pleurisy, enlargement of the spleen, and many other indications of localised but transient syphilitic inflammation occur during the early periods of secondary syphilis.

Affections of the Skin (*Cutaneous Syphilide*).—The affections of the skin are certainly the most important signs of secondary syphilis, for until they appear it is at present impossible to say that a patient has acquired syphilis. The mucous membranes are implicated simultaneously with the skin, the lesions being called condylomata or mucous patches.

The cutaneous syphilides are either scaly, papular, eczematous, pustular, or bullous, for, as Mr. Jno. Hutchinson has well said, "while syphilis may imitate all forms of skin disease, it can create no originals." The rashes of secondary syphilis, as a rule, only involve the superficial layers, so that they do not often ulcerate, and they have certain features which seem to distinguish them from similar eruptions which are not of syphilitic origin.

The secondary syphilitic rashes, like all other manifestations of secondary syphilis, are comparatively slight, and, unless they are subject to irritation or pyogenic infection, have a tendency towards spontaneous cure. They differ in this respect from the tertiary manifestations of syphilis, which ulcerate and show no disposition to undergo resolution.

Cutaneous syphilides are remarkable for the slowness with which they develop and run their course. A few spots may appear many days before the general eruption becomes visible, and as the rash is unattended by inflammation or itching, a careless or unobservant patient may be ignorant of its presence.

Cutaneous syphilides do not present more than a superficial resemblance to the forms of skin eruption which they mimic. They develop in successive crops, and a close examination of the individual spots forming the rash shows that they are not all alike, so that in one place they are maculæ, at another papules, whilst scaly patches may be mingled with pustules. The absence of active inflammation renders the colour of the rash less bright in syphilis than in the ordinary form of skin disease, and the rash is often said, therefore, to be of the colour of lean ham; for the same reason the eruption stands out markedly in syphilis, as there is no surrounding inflammatory zone, whilst the scales in the desquamating forms are less numerous and more easily detached than in simple

dermatitis. There is often a tendency for the spots to develop in curved lines owing to the anatomical arrangement of the capillaries in the skin, and these crescentic, serpiginous, and horseshoe shapes are especially well marked in the ulcerating eruptions of the tertiary stage of syphilis.

Syphilitic eruptions are also found in positions which are not usually affected by the non-syphilitic forms of skin disease. Many forms of secondary eruption are found on the scalp where the hair ends on the forehead, and papules are not uncommon on the face, back of the neck, trunk, and limbs. The erythematous syphilide appears on the chest, trunk, and flexor aspect of the limbs, whilst the squamous form is usually seen on the plantar and palmar surfaces of the feet and hands where the sebaceous follicles are absent. Pustular syphilides resembling acne and impetigo naturally occur where the sebaceous glands are most numerous, and are therefore common on the scalp and the more hairy portions of the body. Ecthymatous and rupial manifestations affect the lower limbs and the trunk most frequently, whilst tubercular nodules occur in any part. Mucous patches and condylomata are formed wherever the skin is thin, moist, and subject to irritation. They are found, therefore, at the margins of the lips, the edges of the nostrils, within the mouth, at the genital and anal folds, near the umbilicus, and between the toes. Certain regions of the body, on the other hand, are nearly exempt from syphilitic dermatitis, though they are not uncommonly affected by parasitic and simple eruptions. Thus the back of the hand, where scabies is common, and the supraclavicular and infraclavicular regions, where it is not unusual to find evidence of lice, are remarkably free from the earlier manifestations of secondary syphilitic skin eruptions.

Treatment.—The treatment in all cases of cutaneous syphilis consists in the internal administration of mercury in the form best suited to the individual patient (p. 467). White precipitate ointment is generally serviceable as a local application, and great benefit will often be derived from mercurial fumigations.

Syphilitic Affections of the Hair and Nails (*Alopecia*).—The structural connection of the hair and nails with the skin renders these appendages especially liable to alterations as a result of syphilis. The hair is affected equally in men and women. It falls out either wholly or in patches soon after the first general eruption on the skin, and this is most often about the second month, though the alopecia may be delayed until the second year after infection.

The prognosis in every case is good, and after a longer or shorter time the hair grows again, even when the alopecia has been complete.

The treatment consists in cutting the hair short, washing the bald surface with soap and water every night, and afterwards rubbing in an ointment made by incorporating half a drachm of white precipitate ointment with an ounce of cold cream or other convenient ointment.

Onychia and Paronychia.—Secondary syphilis may affect the nails either by setting up trophic changes in the matrix—onychia—or by causing a chronic inflammatory condition of the connective tissue of the ungual phalanx in the neighbourhood of the nail—paronychia—which leads secondarily to implication of the matrix. These changes usually occur within the first year after infection with syphilis. As a result of onychia the nail is rendered brittle, grows craggy, is partially detached, or may be shed entirely. The fingers and toes are equally affected. Paronychia may end in ulceration and destruction of the nail, or it may remain as a chronic thickening of the whole border where the nail is inserted into the skin of the phalanx.

The treatment in the ulcerating forms lies in the application of compresses soaked in a solution of perchloride of mercury (1 : 1000), any exuberant granulations being restrained by the application of nitrate of silver or nitric acid. The use of a finger-stall to protect the nail will be useful in the simpler cases when the fingers are affected. As the lesions are rarely isolated manifestations of syphilis, the patient is usually taking mercury when they appear.

The Mucous Membranes.—The manifestations of syphilis on the mucous membranes are of great practical importance, because they are very common and are highly infectious. The mucous membrane of the mouth is affected by a diffuse erythema and by mucous patches. The erythema is especially liable to affect the uvula, the tonsils, and the larynx, causing the sore throat which is well known as a sign of secondary syphilis. The inflammation appears about the same time as, or a little before, the first syphilitic rash. The sore throat is very chronic, and is peculiarly liable to recur from time to time during the first year after infection. The earliest symptom is dryness of the fauces, with slight pain on swallowing, but as the inflammation progresses there is a copious flow of mucus. Examination of the throat at an early period shows that the velum palati, the pillars of the fauces, and the tonsils are uniformly red. In a few days the redness becomes abruptly limited and symmetrical. It never fades away gradually into the surrounding healthy tissues, but is bounded by a distinct line of demarcation. In the further course of the disease the mucous membrane shows sharply defined erosions covered with a red or whitish deposit, and surrounded by a narrow zone of infiltration. Gradually the erosion heals, the infiltration

disappears, and for a time the inflamed mucous membrane appears reddish-brown from congestion.

Mucous patches are most frequently found upon the tonsils, the uvula, the velum palati, and pillars of the fauces, the sides of the tongue, and the mucous surface of the lips, especially the lower. They are often found, too, at the angles of the lips, on the inner surface of the cheek near the last molar tooth, or opposite any point of irritation, and their presence should not be overlooked when they occur on the gums. At first the mucous patches are very slightly elevated, circular or elliptical in shape, and they are often multiple. At a later stage they become the seat of shallow ulcerations with a greyish-yellow surface and uneven edges. This colour makes the patches appear as if they had been formed by pencilling the surface with nitrate of silver, and it is in allusion to this characteristic that they are often called "Plaques opalines" by the French writers on syphilis.

Prognosis.—Mucous patches disappear without leaving any trace in about a month, under simple treatment, in people who are careful to keep their mouths clean and free from irritation, but the patches recur again and again, as a rule, during the first period of secondary syphilis, and as they are a constant source of infection the practitioner should keep them well in mind when he sees his patient. In unhealthy people, and in those who are careless and dirty as regards their mouths, mucous patches may cause considerable trouble, because they may ulcerate rather deeply, or they may coalesce to form larger masses. They often become cracked, especially at the corners of the mouth, where they may lead to permanent scarring, as is often seen in children who have been the subjects of syphilis.

Treatment.—The patient should be warned of the risk he runs of conveying the infection to other persons by kissing, using drinking-vessels or eating-utensils in common. He should be exhorted to use gargles of borax, chlorate of potash, or alum at frequent intervals. I usually paint the patches with chromic acid solution of the strength of 10 grains to the ounce, alternating it occasionally with potassium bicyanide, 15 grains to the ounce. Local applications of chloride of zinc, 20 grains to the ounce, or of nitrate of silver, 30 grains to the ounce, are also useful, and the application of tincture of iodine is sometimes very serviceable. But it is well in every case for the practitioner to make the application himself, either with the patient in a good light or with his throat illuminated from the head mirror of a laryngoscope, as he will then be able to make a methodical investigation of the whole of the mucous membrane of the mouth and pharynx. All causes of irritation should be removed as far as possible, so that smoking should be prohibited, and stimulants forbidden.

The mucous membrane of the tongue, like that of the mouth generally, may be the seat of an erythema or of mucous patches, but as it is somewhat more liable to irritation, and has a thicker covering of epithelium, it proves more refractory to treatment. Various fissures are developed, and the epithelium undergoes modification into the condition known as psoriasis of the tongue, or leukoplakia.

Secondary symptoms of syphilis are rather rare in the *nasal mucous membranes.* They are usually nothing more than a slight hyperæmia of the mucous membrane, leading to a chronic catarrh with a muco-purulent secretion. Mucous patches can sometimes be seen at the external angle of the nostrils, or just inside the nasal fossæ either on the anterior part of the septum or on the inferior turbinate bone. Similar patches may be seen by posterior rhinoscopy on the margins of the posterior nares.

The treatment consists in the administration of a nasal douche of Condy's fluid, two drachms to a pint, or of bicarbonate of soda, 30 grains to the ounce. The larynx is affected with tolerable frequency during secondary syphilis, either in the form of a chronic hyperæmia, superficial ulceration, or as condylomata. The condylomata generally appear as smooth yellow projections, either round or oval, and varying in diameter from an eighth to a third of an inch. They are usually situated on the epiglottis and on the inter-arytenoid commissure, more rarely on the vocal ends themselves, and being less exposed to irritation they are not so liable to ulceration as the condylomata occurring on the pharynx. The laryngeal manifestations of secondary syphilis generally occur from six to twelve months after infection.

The symptoms are generally slight, a little cough and hoarseness, which may pass on into complete aphonia, being all that the patient complains of. A perchloride of mercury spray of the strength of 1 in 1000 is often of great service when it is combined with the internal administration of mercury.

The neighbourhood of the anus, the vulva, and the inguinal folds are often the seat of flattened ulcerated patches, secreting a scanty viscid secretion, which are known as condylomata lata. The discharge is often stinking, and is highly infectious. Condylomata are associated with a great want of cleanliness on the part of the patient. They are cured by keeping the parts perfectly clean and dry, whilst the patient is put upon a course of mercury. The drying is ensured by dusting the condylomata with a mixture of calomel and oxide of zinc, or if the discharge is too profuse the patient may be placed in a bath of perchloride of mercury of the strength of one-half to one per cent. Condylomata of long standing, or

which are exuberant, may require the application of a Pacquelin's cautery or of cauterisation with nitrate of silver.

The Eye.—Iritis.—Inflammation of the iris is one of the chief manifestations of secondary syphilis in the eye, as it has been estimated that nearly 60 per cent of all cases of iritis are due to this cause. It may occur within six weeks or two months of the primary lesion, and is often accompanied by cyclitis. It is usually acute, one eye being first affected, though the other eye soon becomes inflamed.

Symptoms.—There is some congestion of the conjunctiva and circumcorneal zone, with photophobia and lacrymation. The pain, however, may not be a very marked feature, though the patient may complain of some neuralgia over the forehead and down the side of the nose. In a typical case one or more beads of lymph can easily be seen to be situated upon the iris, and the pupil is small and irregular in shape. More often, however, no such beads of lymph are present, and the whole iris appears thick and dull. The inflammation runs its course in about a month or six weeks, and is singularly amenable to treatment by mercury. Relapses are not very common in cases which have been cured by treatment, but if they are left to undergo resolution it is not unusual for adhesions to be formed between the margin of the iris and the front surface of the lens. These synechiæ may be the cause of fresh irritation, which results in renewed attacks of iritis, or, if complete, they may cause a chronic inflammation ending in glaucoma.

Treatment.—The after-effects of a neglected syphilitic iritis are so disastrous that every effort must be made to cure it absolutely. The patient should be kept in a darkened and well-ventilated room so long as he complains of photophobia, and he should be forbidden absolutely to use his eyes. Repeated instillations of sulphate of atropine, 2 grains to the ounce, with fomentations of belladonna, are imperatively called for until the pupil is widely dilated and the inflammation has subsided. These instillations may be supplemented with fomentations of belladonna, as by these means the tendency to the formation of synechiæ is reduced to a minimum. If atropine increase the tendency to conjunctivitis, it must be replaced by duboisin or hyoscyamin. Three leeches or a small blister applied to the temple, where the hair has been shaved away over a small area to hide the subsequent scars, will often relieve the pain. The patient must be put upon full doses of mercury (p. 468), which should be increased rapidly until there are symptoms of slight salivation, when the amount must be cautiously reduced. Much care must be exercised when recovery has taken place, especially if synechiæ are present, and the patient should report himself to his ophthalmic surgeon from time to time, to enable an ophthalmoscopic examination to be made.

Ear.—As the external ear is only a part of the skin, it is occasionally affected with an erythema, which may involve the mastoid region, the auricle, or even the membrana tympani. A condyloma is sometimes formed within the external auditory meatus, where it may give rise to much discomfort and considerable discharge. The treatment is identical with that recommended for secondary syphilitic affections elsewhere, viz. a course of mercury internally, cleanliness, and drying of the local manifestation.

Treatment of Secondary Syphilis

The methodical treatment of syphilis begins as soon as the disease can be diagnosed with certainty, and in the majority of cases this is not until the appearance of the secondary symptoms. A good prognosis may be given in young patients who are otherwise healthy, for they may be told that if they will submit themselves to a thorough course of treatment the secondary symptoms can be kept well under control, and it is improbable that they will suffer from any tertiary signs unless perchance they are subject later in life to some unusually debilitating influences. On the other hand, the intemperate, the tuberculous, the rheumatic, the gouty, the malarious, and those who are suffering from any wasting or debilitating disease do not bear syphilis well, and it is advisable to warn such patients at the outset that their cure will be harder and will take a proportionately longer time.

The broad facts to be remembered in connection with syphilis are as follows, so far as they can be based upon our present knowledge of the pathology of the disease. Syphilis leads to a chronic inflammation of the connective tissues, as is shown by a multiplication of small round cells. In the early stages these small round cells have a tendency to degenerate in various ways, this tendency being controlled by the administration of mercury. In the later stages the tendency to degenerate is associated with certain conservative changes, for there is a production of imperfect fibrous tissue. This formation of fibroid tissue is controlled by the use of iodides. The stress of the disease in syphilis usually falls upon one system, *e.g.* the bones, the skin, the nervous system, the visceral organs, and in some cases a definite cause may be discovered to account for the predilection. But any independent condition or disease which unfavourably modifies the connective tissues of an organ, or even of the whole body, will unfavourably influence the course of syphilis.

It does not matter materially by what means mercury obtains access to the tissues, so long as it is presented to them in a form which they can assimilate. It may pass by absorption

through the mucous membrane of the alimentary canal: it may be taken up by the cells of the sebaceous and sweat glands of the skin, or it may be introduced directly into the lymphatics of the connective tissue.

Internal Administration.—It should be remembered when mercury is given by the mouth, that it is liable to act as an irritant during its passage over a long tract of delicately adjusted mucous membrane, whose tendency is towards inflammation if the balance be disturbed, and whose secretions, now acid, now alkaline, aided as they are by the unknown action of the intestinal micro-organisms, may alter the chemical constitution of the mercurial preparation so as to make it a violent irritant.

Mercury in long-continued doses is a depressing remedy, and is especially badly borne by those who are predisposed to tubercle. In syphilis, mercury must be given for many months, and in sufficient doses. Other considerations, therefore, have to enter into the course of treatment besides that of the particular form in which the drug is to be administered. The hygiene of the patient, both locally and generally, must be carefully attended to, and he must be maintained in the pink of condition, so far as his circumstances will allow. The surgeon must become thoroughly acquainted with the physical, mental, and moral peculiarities of his patient, for in the case of a prolonged course of treatment he will often have need to deal with every aspect of his character.

The local hygiene will consist in a careful regulation of the teeth by a competent dentist. Tartar should be removed, caries should be arrested, and every cause of local irritation should be averted. The patient should be told plainly that the irritation of smoking tends to promote the formation of mucous patches in the mouth, and that by their presence he may infect others. The function of the alimentary tract should be brought to the highest level of perfection by correcting dyspepsia and relieving constipation, whilst the most strict moderation is enjoined both in eating and drinking.

The general hygiene consists in warning the patient against any excess, whether of fatigue or luxury. Regular habits, early hours, and moderate exercise will amply repay the patient by shortening the term of his cure, and these simple means have built up the reputation of many a spa as a syphilis-curing watering-place. Indeed, the only way to secure these advantages to a patient is often to send him to such a place, for so long as he stays at home he will take no care of himself.

I think it is best to begin the administration of mercury in syphilis by the method of internal administration, and of all the preparations of mercury it is certain that for English use grey powder or hyd. cum cret. is the best. It is easily carried about in a compressed form, each "tabloid" containing three grains. The patient should be ordered to take a "tabloid" three times a day directly after a meal. Perchloride of mercury comes next in favour, and it has the advantage that it can be readily prescribed with iodide of potassium when it is considered advisable to give the two drugs together. The dose is a drachm of the solution of perchloride of mercury, containing a sixteenth of a grain of hyd. perchlor., in an ounce of chloroform water. The protiodide of mercury, hyd. iod. viride, or hydr. iod. flavum, is also very largely used in the treatment of secondary syphilis. The dose is a quarter or a third of a grain given three times a day directly after food, the quantity of the drug being increased during the first fortnight to a grain and a half or two grains thrice a day. It may often be usefully combined with 2 to 4 grains of the green extract of hyoscyamus. Tannate of mercury in half-grain doses with sugar of milk has attained considerable repute, but its action must be watched rather more carefully than the other preparations, as it may cause much gastro-intestinal disturbance. Many other preparations of mercury have been brought forward from time to time, calomel and blue pill being the older forms; carbolate, salicylate, and alanilate the more recent; but they do not seem to be so satisfactory in their actions as those recommended above. Zittman's method of giving mercury is described at page 471. It must be borne in mind, however, that no single preparation of mercury can be administered in a routine manner, because a preparation which suits one patient cannot be taken equally well by another, nor by the same patient at all times. The surgeon, therefore, has to vary both the preparation and the means of administering the drug. Symptoms of salivation, pains in the chest, and gastro-intestinal disturbance are the most common symptoms which prove troublesome during a course of mercury, and it is well to try and combat these symptoms by a temporary reduction in the dose, a modification in the food, and a limitation of the quantity of fluid ingested, rather than to fly at once to the administration of opium or Dover's powder. A little essence of ginger, peppermint, or other carminative will often be sufficient to give relief. The administration of mercury must be carried on for at least six months from the time the diagnosis of syphilis has been first made. I prefer to give the patient a rest from mercury by the mouth for three days at the end of each month, and a fortnight at the end of the third month, and it is often necessary to suspend or reduce the dose for a day or so on account of trifling digestive disorders; but so long as the weight of the patient is maintained, and he appears to be improving, the dose of mercury should be steadily administered. For this purpose I cause the patient to be weighed every Saturday, if

possible upon the same machine, the record of his weight being put into writing at once.

Inunction.—The method of administering mercury by inunction comes next in efficacy, even if it do not surpass the plan of internal administration during the secondary stage of syphilis. Inunction, however, has its limitations, and they are even more marked than those of the method usually adopted. It is dirty, it requires time, it is likely to give rise to a troublesome eczema, and it produces salivation unless it be administered carefully. Inunction is often serviceable for a short time whilst the patient is resting from the internal administration, so that it may be employed for a fortnight once in three months.

The following directions are to be given to the patient. He is to procure freshly prepared blue ointment put up in gelatin capsules each containing thirty grains. He retires early in the evening, and takes a warm bath, thoroughly washing the parts to be anointed with soap and water. He then dries himself and puts on pyjamas and a flannel dressing-gown, his room of course being warmed in cold or damp weather. The most accessible hairless regions are employed for the inunction. These are the inner surface of the thighs, the inner surfaces of the arms and forearms, the sides of the chest, the loins, the buttocks, the soles and the inner surface of the feet. One of these regions is selected in order, so that each part only receives its inunction occasionally. The part to be anointed is sponged over with a solution of biniodide of mercury of the strength of $\frac{1}{1000}$, and afterwards gently dried with some absorbent wool, for it is important that the skin should be kept aseptic. Twenty grains of the blue ointment are then smeared over the surface of the skin at the selected spot, and briskly rubbed in with the hand over as large a surface as possible, and for not less than twenty minutes by the clock, an additional ten grains being added during the inunction. All the ointment should have disappeared by the time the inunction is complete and the skin presents a greyish colour, as if it had been lightly blackleaded. The patient then takes off his dressing-gown and goes to bed, after washing his hands with soap and hot water to remove any ointment which may be adhering to them. He has a warm bath on the morning following the inunction to remove any ointment which has not been absorbed or rubbed off during the night. The dose of ointment may be gradually increased from half a drachm to sixty or ninety grains, though in some cases it may be necessary to give more.

The results of this method of treatment are often very satisfactory. The patient begins to gain in weight, his appetite returns, his digestion improves, he sleeps well at night, and he ceases to be listless. In such cases, and when mercury is badly borne during internal administration, the method of inunction may be continued for 50 to 100 days, the patient being carefully watched during the second and third weeks, when he may suddenly develop a troublesome stomatitis. If special care be taken to keep the skin aseptic and to avoid rubbing the ointment into hairy parts, the risk of dermatitis will be materially reduced. It is well to secure the services of a professional rubber in these prolonged courses, though of course with an intelligent patient it is not absolutely necessary.

Fumigation.—Some cases of dense or widely distributed eruptions on the skin and of obstinate ulceration receive much benefit from fumigation with mercury when other methods have failed. This plan of giving mercury fell into disuse owing to the difficulty of administration, but of late years, with the invention of cheap and portable Turkish baths, it has been somewhat revived. The patient sits naked in the vapour bath, and below him thirty grains of calomel are vaporised by a small spirit lamp. The vaporisation takes twenty minutes, and at the end of that time the lamp is extinguished and the patient remains in the bath ten minutes longer to cool. He then goes to bed. It is only necessary to volatilise the calomel and not to add any water, for profuse perspiration on the part of the patient will defeat the object for which the bath is given. In all cases the patient should be within easy reach of help whilst he is taking the bath, as he may faint or be accidentally scorched. The baths should not be taken directly after meals, and at first they should only be administered every other day. They may be continued for a month or two if the result is satisfactory, but they are more often used temporarily and for a special purpose.

Hypodermic Injection.—The desire of many men to advance their art, and the wish of patients to be cured of syphilis by some short method which shall cut at the root of the disease, have lately led to the treatment of syphilis by the hypodermic injection of a very large variety of mercurial preparations, some soluble, others insoluble. The method has fallen into disrepute from the unwarrantable claims made in its behalf. There is no rapid cure of syphilis, and practitioners mislead their patients if they hold out to them any hope of materially shortening the ordinary course of treatment by any method known at present.

There are, however, some conditions under which hypodermic injections of a mercurial preparation may be usefully employed. When mercury is badly borne by the alimentary tract, or by the skin, a hypodermic injection is sometimes well borne, and as it is imperative that mercury should be given in syphilis, such injections are then advantageous. In like manner hypodermic injections are to be given

when an acute inflammation of the bowels, lungs, liver, or throat make it unwise to give mercury by the mouth. Then there are the unhappy class of patients who are always wanting some alteration of treatment, or who, demanding that something more may be done, receive some moral support by the slight physical pain attending this administration.

The chief soluble salts of mercury which have been recommended for hypodermic administration are corrosive sublimate from a twelfth to three quarters of a grain: asparagin-mercury made by dissolving two and a half drachms of asparagin in warm water and adding oxide of mercury to saturation. The solution is filtered, and the mercury being estimated, fifteen minims of a 1 per cent solution are injected. The succinimide of mercury, the oxycyanide, the iodo-tannate, the carbolate, the formamide, the alaninate, and the benzoate have all been employed with varying success. The insoluble forms are mercury itself, calomel in doses of one-half to two grains, the yellow oxide, the neutral salicylate, the thymolacetate, and many other forms. Grey oil, oleum cinereum, was introduced by Dr. E. Lang, the Professor of Dermatology and Syphilography at Vienna. It is made by making an ointment of mercury with lanoline as a basis and then diluting with oil of vaseline. (The actual formula is, Lanolini anhydrici ʒiv., chloroform ℥jss. Evaporate in a large mortar with continual stirring, then add Hydrarg. vivi depur. ʒj. Stir slowly until the chloroform is wholly evaporated and the metallic mercury can be no longer distinguished. Add 135 grains of this ointment to 45 grains of vaseline oil, the oil being added so gradually and with such constant stirring that a smooth, oily mixture is obtained. Keep in a wide-mouthed phial with a glass stopper.) The dose of this preparation is one minim for an injection.

Perchloride of mercury seems, however, to give the best results in the hypodermic injection of mercury. The solution must be freshly made, and should be so standardised that ten minims contain a quarter of a grain of corrosive sublimate. Five minims of this solution are injected on the first occasion, and the dose is gradually increased to a quarter, five-eighths, or even three-quarters of a grain. The injection should be given every second or third day, though the intervals must be longer if symptoms of commencing salivation appear. The injection is made into the subcutaneous tissue, care being taken to avoid the puncture of a vein. A point is selected which is not liable to accidental irritation or contamination, and for this reason the depression behind the great trochanters of the femur is often chosen. Many surgeons, however, prefer to throw the injection deeply into the substance of the gluteal muscles. It is absolutely necessary that the skin of the patient, the solution, the hypodermic syringe, and the needle should be absolutely sterile, and the greatest care must be taken to secure this asepsis. A piece of cyanide gauze soaked in collodion should be applied over the seat of puncture. Yet in spite of every precaution abscesses may be formed at the punctures, because a patient debilitated by syphilis is prone to suppurate on the very smallest provocation.

An attempt has been made to administer mercury by means of baths, the best-known form of bath being one of corrosive sublimate with or without the use of electricity. Gaertner's bath consists of two cells, which should be divided by a properly fitted diaphragm. Each cell is attached to one pole of a battery consisting of about fifty large Leclanché elements; the box which contains the battery is supplied with a finely graduated rheostat, a galvanometer, and a commutator. About half an ounce of corrosive sublimate is thoroughly dissolved in a warm bath, and as soon as the patient is immersed the diaphragm is put in place, the poles of the battery are attached, and the current is gradually increased by means of the rheostat until it is of the strength of 200 milliampères. The current is allowed to flow through the bath for a quarter of an hour; it is then reduced, reversed, and again increased from 100 to 200 milliampères. At the end of a second quarter of a hour the current is shut off and the bath is finished. These baths are said to be especially serviceable in the treatment of mucous patches and other forms of cutaneous syphilis.

Salivation.—People vary greatly in their susceptibility to mercury: some can take the drug in considerable quantities for long periods of time, whilst others are readily affected by small doses only given for a short period. In the slighter cases of salivation which warn the surgeon that his patient has reached the limit of tolerance, there is a slight inspissation of the saliva, which becomes tough, stringy, and increased in quantity. The teeth are tender when the jaws are snapped together. The patient begins to look pale, he loses his appetite, and may complain of headache, giddiness, and transitory pains in his limbs. The muscles of the face twitch, the fingers tremble when they are spread out, and the tongue is tremulous when protruded. The patient often becomes shy and nervous when he thinks that he is being watched; he sleeps badly and often has nightmare. A rash may also appear on the skin, either as an erythema, a wheal, or an ecchymosis. The rash runs its course in a few days, ending in degeneration. In the more marked cases of salivation the patient complains of a coppery taste in his mouth, his breath smells offensively, there is some ulceration of the gums with congestion and œdema of the mucous

membrane of the mouth, which may extend backwards until the tonsils and pharynx are involved. The teeth may become loose, and there is an enormously increased flow of saliva, with swelling of the parotid and submaxillary glands. The psychical condition changes from shyness to despondency, and in women menstruation is diminished or ceases.

It often happens that a course of mercury produces symptoms connected with the intestinal canal rather than with the mouth. The patient complains of colicky pains with abdominal rumbling and diarrhœa shortly after taking each dose of the medicine, and the diarrhœa may be so severe as to be bloody.

Treatment of Salivation.—Commencing salivation indicates that the amount of mercury taken by the patient must be diminished. The teeth should be brushed once or twice a day with equal parts of tincture of myrrh and tincture of iodine. Great care should be taken to prevent any accumulation of food between the teeth, and the patient should be directed to wash out his mouth with a saturated solution of boric acid after each meal. Alum and chlorate of potash, of each a drachm and a half in twelve ounces of water, also forms a good mouth-wash; whilst if the breath be foul a drachm of the chlorinated soda may be mixed with an ounce of brandy in four ounces of water to serve as a gargle. Atropine is alone of service in checking the profuse salivation. It should be given frequently in small doses in the form of powders, which are allowed to dissolve in the mouth. A thirty-second of a grain of atropine mixed with a drachm of sugar of milk may be divided into ten powders, of which one may be given every four hours until the pupil begins to dilate. Five or ten grains of Dover's powder given at night are usually sufficient to allay the intestinal symptoms, which are often marked at the beginning of the mercurial course; but the use of opium should not be persisted in, and the symptoms disappear spontaneously in many cases after a few days' discomfort. A tonic treatment by the administration of quinine and iron may be given for a short time after the symptoms of salivation have disappeared, before the patient recommences his mercurial course. There is no doubt that, even after a prolonged course of mercury, the whole of the drug is eliminated from the body within two years of the last dose being taken, though there is a popular belief that when mercury once gets into "the system" it is never afterwards got rid of. It is chiefly excreted by the kidneys and skin. Patients with renal disease, therefore, are bad subjects for a prolonged course of mercury; and though albuminuria does not necessarily contra-indicate the use of mercury in the treatment of syphilis, it makes the surgeon somewhat more careful in the watch he keeps upon his patient. People who suffer from tubercle, malaria, advanced anæmia, the hæmorrhagic diathesis, and chronic disease of the alimentary tract also bear mercury badly as a rule.

Tertiary Syphilis

It must be remembered that the expression tertiary syphilis is only used for the sake of convenience to express the latest manifestations of syphilis, which are more refractory to treatment than the earlier signs. The symptoms of tertiary syphilis usually appear during the third or fourth year after infection, but they show themselves as early as the second or fourth month, or they may be delayed until some debilitating cause weakens the general health of the patient. In favourable cases and under proper treatment no tertiary symptoms may present themselves, the patient being cured in the secondary stage.

Malignant Syphilis.—In some unfortunate cases an attack of syphilis runs a malignant course which often terminates in death. The skin eruptions are a marked feature in malignant syphilis, and they quickly ulcerate, but the mucous membranes are only slightly affected. The bones and nervous system show evidence of the syphilitic poison, and the whole organism is seriously affected, as is shown by the fever and cachexia. Pathology will not as yet explain the cause of malignant syphilis, though it is probably the same as that of malignant scarlet fever, acute septicæmia, and malignant small-pox, *i.e.* a diminished power of resistance on the part of the tissues rather than an increased virulence of the infective agent. Such cases of malignant syphilis have been observed in individuals who have seemed otherwise to be in good health, as well as in those suffering from dysentery, tuberculosis, scurvy, anæmia, and chronic alcoholism.

Treatment.—Mercury is badly borne in these cases, and iodide of potassium is often found to be too depressing. Sir Alfred Cooper speaks very highly of Zittman's regimen, of which he gives the following account:—"The course of treatment extends over a fortnight, during which time the patient is put upon a strict diet and regimen. The following are the details of this method of treatment.

The decoctions and pills are made from the following formulæ:—

Zittman's decoction No. 1.

℞ Rad. sarzæ contus. ℥iv., sem. anisi contus., sem. fœniculi contus. āā gr. 80, fol. sennæ ℥j., rad. glycyrrhiz. contus. ℥iv.

And in a linen bag:—

Sacch. alb., alum. sulph. āā ℥ij., hydrarg. subchlor. gr. 80, hydrarg. bisulph. rub. gr. 20, aquæ C. iij.

Boil down gently to one gallon, strain and put into four forty-ounce bottles. Label—The Strong Decoction.

Zittman's decoction No. 2.

To the dregs of No. 1 decoction add :—

Rad. sarzæ contus. ʒij., cort. limon. contus., semin. cardamom. contus., rad. glycyrrhiz. contus. āā ʒj., aquæ C. iij.

Boil gently down to one gallon, strain and put into four forty-ounce bottles. Label—The Weak Decoction.

℞ Hyd. subchlor. gr. ij., ext. colocynth. co. gr. v., ext. hyoscyami gr. ij.

M. Ft. pil. ii. signa.—the Pills.

The patient is kept in a room at 80° F. The diet consists of :—

Breakfast—Boiled egg or bacon, tea, no sugar or spices. Lunch—Butcher's meat, vegetables, no fruits. Dinner—Soup, fish, poultry.

The evening before beginning the treatment, the two pills are taken, and for the next four days, at 9 a.m., 10 a.m., 11 a.m., and 12 noon, half a pint of the strong decoction is to be drunk very hot, and at 3 p.m., 4 p.m., 5 p.m., and 6 p.m., half a pint of the weak decoction cold. The patient is kept in bed except for an hour in the evening. He is allowed to get up on the fifth day ; he may then have a hot bath and dress, and is allowed, if he asks for it, a little brandy, or whisky and soda. In the evening two pills are administered, the patient starting the decoctions as before. So the treatment goes on until the fifteenth day, when it is discontinued.

Any one who has not witnessed the results obtained by this method of treatment, when the iodide and mercury plan have been pursued with no apparent benefit, will hardly credit us when we state that we have seen many cases in which ulceration was progressing rapidly in spite of ordinary antisyphilitic treatment, quite heal up under a course of Zittman." So, too, among the subjects of chronic syphilis affecting the nervous system, we have had many successful instances treated by this method, and strongly recommend it in selected cases.

Course of Tertiary Syphilis.—Cases of malignant syphilis, however, are fortunately of rare occurrence—much more rare, indeed, than the cure of syphilis in the secondary stage. The usual course is for the patient to present slight but continuous symptoms of syphilitic poisoning in the form of eruptions on the skin, which gradually cease to show the symmetry characteristic of the secondary rashes. The mouth and throat are implicated in the changes, and the lesions no longer show a tendency to run a definite course and to disappear, but are rather inclined to become chronic, ulcerate, and even slough. The connective tissues are still most affected, and the stress of the disease generally falls upon one part of the system more than upon another, so that in one person the bones and periosteum are widely and deeply inflamed, in another the viscera, in another the nervous system, and in another the arteries. No reason can be given for these variations in the manifestation of the syphilitic poison except by saying that the stress of the disease falls upon the least resistant form of connective tissue in each person. Lastly, the iodides administered internally have a greater curative effect than the salts of mercury, though the two metals must often be combined to obtain the best results.

Pathology.—The gumma is as characteristic of the tertiary syphilis as the condyloma is of the second stage of the disease. A gumma appears as a new formation varying in size from a grain of wheat to a large tumour. It may be sharply circumscribed, it may be diffuse, or it may present radiating processes. It is always derived from connective tissue, and it consists microscopically of a delicate intercellular stroma filled with small round cells, and sometimes provided with newly developed blood-vessels. Some of the cells undergo further changes, becoming epithelioid and polynuclear, and though a gumma is very chronic, it sooner or later undergoes disintegration. The cells are subject to fatty degeneration, which causes the gumma to become purulent and discharge its contents externally. An ulcer is then left which heals and leaves a scar. In other cases the cells forming a gumma may disintegrate into a granular mass which is afterwards absorbed, or the cells may increase in size, fuse to form giant cells, which afterwards caseate—the whole gumma being absorbed without leaving any apparent trace, or causing any permanent injury to the physiological function of the organ in which it grew. More usually, however, this disappearance is less complete, for the gumma in its growth destroys the original tissue in which it grew, and when it has been absorbed, its place is taken by cicatricial tissue which may distort the tissue and materially impair its use. Very often, too, the growth of the gumma is associated with a new formation of connective tissue caused by the irritation to which it gives rise. This scar tissue interferes with the nutrition of the cells, which undergo caseation, and at the same time prevents their absorption, so that a hard fibrous nodule or mass is produced which may suppurate if it becomes infected with pyogenic organisms. The central mass of caseating material is then extruded, and an ulcer with indurated edges remains.

The infectivity of tertiary lesions in syphilis is unknown. It is probable that the secretions containing cells from the earlier tertiary manifestations are capable of conveying syphilis, whilst those from the latest forms are inert.

Vascular System.—The heart, arteries, and veins are all liable to be affected by the syphilitic poison, for both contain abundance of connective tissue.

Heart.—Gummata of the heart have been repeatedly observed, and they attain their largest size in the ventricular septum. Syphilis also

gives rise to a fibrous myocarditis and to an endocarditis which may attack the lining membrane of the heart, to a thickening of the valves, or to an inflammation of the coronary arteries. The pericardium is rarely affected without coincident inflammation of the heart itself.

The symptoms are broadly those of myocarditis due to the more usual causes. The patients often die suddenly, and the syphilitic lesion may only become manifest at the post-mortem examination, for the heart is affected late in the course of syphilis when no history of the disease is attainable. The diagnosis, therefore, is rarely made, but in a few cases recovery is said to have occurred under appropriate treatment.

The arteries are affected by syphilis in several ways. There may be a general arteriosclerosis, which is either diffuse or nodular; an endarteritis, which may be obliterating or gummatous; a hyaline or amyloid degeneration of the arterial walls; or an aneurysm. It is probable that many syphilitic manifestations in the arterial system as well as in other parts of the body are *parasyphilitic* (p. 480), that is to say, they are only due indirectly to syphilis. These tissues have shared in the general syphilitic poisoning to which the whole body has been subjected. They have been weakened, and they have thus become more liable to disease, which in the ordinary course of events would have affected them, but perhaps to a less extent or from which they might have wholly escaped. The aorta, the cerebral arteries, the radial, the temporal, and the popliteal are the vessels most often affected; and in the smaller arteries the proliferation of the endothelial cells may be so great in syphilitic endarteritis as to cause complete obliteration of the lumen, but without any atheromatous degeneration.

Veins.—The veins are subject to a syphilitic phlebitis or periphlebitis which may attack the superficial veins of the arms and legs, or may even involve so large a vein as the common femoral. The plugging is not painful, and there is rarely evidence of acute inflammation.

The result of these syphilitic changes in the blood-vessels is to produce marked disease of the brain when they occur in the cerebral arteries, and to cause gangrene when they involve the vessels of the limbs.

The prognosis is not very good, because the symptoms are often indicative of advanced disease of the vessels in which they occur.

Bones and Joints.—Syphilitic lesions of the bones and joints are numerous and characteristic, and they occur during each of the three main stages into which syphilis is divided for descriptive purposes. Neuralgia over the large joints relieved by mercury is of no uncommon occurrence during primary syphilis, especially in those who live in damp and warm climates. Bone pains known as osteocopic are of frequent occurrence during secondary syphilis, but it is not until the tertiary stage that the full force of the disease falls upon the osseous system.

Bone is divided for pathological purposes into an inorganic portion of no interest, and a living organic part, which includes the marrow and endosteum, extends through the whole thickness of the bone, and terminates with the outer layer of the periosteum. This living tissue is alone capable of inflammatory changes, and the whole of it is involved, though the changes may be more marked at one part than another, so that the inflammation can be divided clinically into periostitis, osteitis, or osteomyelitis.

Local periostitis, especially as it occurs on the shins, is so common and well recognised as a sign of syphilis that its old name *node* has passed into folk-speech. But nodes are not confined to the tibia, for they may be found on all bones lying subcutaneously, and thus exposed to injury. Both long and flat bones are attacked, so that nodes are found upon the skull as well as on the bones of the arms and legs.

The tumours formed by this form of syphilitic periostitis are ill-defined swellings, adherent to the bone, over which the skin moves easily unless they are inflamed. Nodes are tender and are often more painful at night than when the patient is following his occupation during the day. Treatment with iodides causes the localised periostitis to undergo resolution; but in some cases when the patient is unhealthy, and when the inflammatory process becomes infective, the nodes suppurate, an ulcer is formed, and there may be some necrosis of the affected bone.

Osteitis and Osteomyelitis.—It is impossible to distinguish pathologically between osteitis and osteomyelitis, though the periostitis is often sufficiently localised in syphilis to enable it to be classed separately.

In long bones the gummatous inflammation may be either localised or diffuse. When it is localised it may cause sufficient rarefaction of the bone to allow of its being broken by a slight injury—"spontaneous fracture." More usually, however, the inflammation affects the entire bone, which, in process of time, may become thickened, heavier than usual, and bent, so that it may be mistaken for a case of osteitis deformans. Suppuration is rarer in syphilis than in tubercle, and necrosis is consequently less common.

Dactylitis is one of the less common forms of syphilitic osteomyelitis. The affected phalanges increase in size and the skin becomes glazed, but it does not ulcerate unless the inflamed tissues become infected with pyogenic organisms. There is another form of syphilitic dactylitis in which the inflammation appears to start in the subcutaneous tissue rather than in the bone itself.

Bones containing an abundance of cancellous

tissue are especially liable to syphilitic osteomyelitis. Thus there is a syphilitic spine just as there is a tuberculous spine—though it is commoner in the cervical than in the dorsal region,—whilst the bones of the head and face are well known to be particularly susceptible to syphilitic disease. The resulting deformities are often of very serious import to the patient, for the whole character of his face may be altered by the loss of the bridge of his nose, whilst a marked alteration in the voice may be produced by a syphilitic ulceration of the hard palate.

Soft nodes occur on the vault of the skull as a result of a gummatous infiltration, which is laid down between the bone and the dura mater on the inner side, or between the bone and the pericranium on the outer side. Progressive absorption takes place, and the whole thickness of the bone may be removed; more often only the external or internal plate is disintegrated by a process of serpiginous infiltration, the result of the fusion of several circular gummata. The scalp feels boggy over the affected parts, and occasionally pulsation is felt where the bone is perforated. It is not usual for suppuration or necrosis to occur, and the softened spots should not be incised with the idea of letting out pus.

The joints are less often affected in tertiary syphilis than the bones. The best-known forms are the gummatous synovitis, which somewhat resembles the allied tuberculous form, and a more advanced type of disease—chondro-arthritis—in which the articular end of the bone is removed by a gummatous ulceration, leaving a thin membrane, representing the cartilage, over the ulcerated surface. Both forms of disease are very chronic, and the gummatous synovitis, so far as I have seen it, may be distinguished from the tuberculous form by the comparative absence of pain, and by the readiness with which the patient can use a joint which is apparently seriously disorganised. Chondro-arthritis may occur in many joints, and it may be associated with extensive gummatous periostitis.

The prognosis is good during the earlier stages of syphilitic inflammation of the bones and joints, but when the lesions are of long standing there is no remedy which will cause the reabsorption of scar tissue or the rarefaction of sclerosed bone. Plastic operations on the face to remedy the ravages of syphilis should not be lightly undertaken, but if there is no active ulceration an attempt may be made to remedy a defective bridge to the nose by the subcutaneous injection of paraffin, whilst holes in the palate may be closed by the resources of the dentist's art.

Bursæ. — The out-patient room of every general hospital in a large town will show cases of gummatous inflammation of the bursa patellæ, or of that at the insertion of the ligament patellæ; but though these are the usual bursæ to be affected, similar enlargements are found in the semi-membranous, iliopsoas, olecranon, and trochanteric bursæ, as well as in those at other parts of the body. The enlargement is painless, and is unaccompanied by inflammation, unless as a result of injury. The bursa is either hard or quite elastic. It gradually becomes adherent to the skin, and a typical gummatous ulcer is formed, which will heal readily enough, if it be kept, clean, under the influence of a course of iodides.

The Eye and its Appendages. — The eye suffers frequently and severely from the effects of tertiary syphilis. *The eyelids* may be the seat of gummatous ulceration, and the conjunctiva of a chronic catarrhal inflammation. A localised gumma of the conjunctiva which may involve the sclerotic is not uncommon. It may ulcerate and leave a scar.

Iritis with its sequelæ is at once the most common and the most troublesome manifestation of tertiary syphilis. Its symptoms and appropriate treatment have already been indicated (p. 467). The danger of its subsequent complications is due in part to the inflammation involving the ciliary body and the choroid; in part to the continued irritation produced by the presence of synechiæ, which are adhesions between the edge of the iris and the anterior layer of the lens capsule.

Cornea.—The cornea is sometimes marked by small dots of different sizes, which are situated on its posterior surface — punctate keratitis. The dots are often arranged like a cone, with the apex at the margin of the pupil. The condition is due to the fluids of the eyeball circulating through the pupil, and bringing with them epithelial deposits and cells, which are deposited upon the posterior surface of the cornea. Keratitis punctata, therefore, is sometimes a symptom of iritis and cyclitis. But in addition to this there is a true syphilitic parenchymatous inflammation of the cornea, which is not associated with iritis, and which disappears gradually and entirely under constitutional treatment.

Cyclitis.—An attack of iritis may pass on into, or may be associated with, inflammation of the ciliary body, which is known as cyclitis. The symptoms consist of a deep circumcorneal zone, great pain of a neuralgic character, diminished intraocular tension, and marked interference with vision, for the media of the eye are hazy. The condition is rarely limited for any length of time to the ciliary body, but it soon spreads over the whole uveal tract of pigmented tissue of the eye.

The treatment of cyclitis is practically the same as for iritis, but iridectomy is required if the iritis recurs and synechiæ are present.

Choroiditis occurs in two forms, acute and chronic. Acute choroiditis is met with at an

earlier period in syphilis than the chronic or disseminated form. It is often associated with retinitis, the patches of exudation being small, yellowish in colour, and situated near the periphery. The vitreous is cloudy and hazy and the pupil is dilated.

The patches of inflammation in disseminated choroiditis are scattered over the fundus of the eye, though they are especially numerous at the periphery Both eyes may be affected, and as the symptoms are less marked than in the acute form, the changes are often far advanced when the patient first comes under skilled observation. There is then more or less extensive atrophy of the pigment-cells, though the sight is often fairly good until the central portion of the fundus is involved.

The treatment of choroiditis is essentially the same as that recommended for syphilitic iritis, atropine being most useful in the acute form of the disease. A course of mercury may be prescribed in the chronic form, to be followed by the administration of iodide of potassium, sodium, or ammonium. The condition of the vitreous sometimes gives a clue to the value of the treatment adopted, for it may become more translucent in the favourable cases, whilst at other times it maintains its opacity or flakes.

Retinitis, unassociated with choroiditis, occasionally occurs in the later forms of syphilis, leading to a diminution of central vision, with hemeralopia, in which the vision fails rapidly as twilight increases, until patients are practically blind in subdued lights. The patient may complain of subjective flashes of light, or of vibrating or rotating spots of light. The details of the fundus in the affected parts are hazy, the disc looks hyperæmic, and there may be retinal hæmorrhages.

The prognosis is good if the constitutional treatment be thoroughly carried out.

Syphilitic inflammation of the motor nerves of the eye, and of the optic nerve itself, are well-recognised conditions, but as a result of intracranial rather than of intraocular causes, though occasionally a periostitis of the orbital plate will give rise to symptoms of papillitis or of squint. In the majority of cases, however, the third, fourth, or sixth nerves are involved in a gummatous inflammation of the dura mater as they pass through the foramina at the base of the skull. The sixth nerve is most often affected by inflammatory changes at the base of the brain, because it has the longest course on the floor of the skull. More rarely the nuclei of the nerves in the brain may be affected as a consequence of endarteritis of the cerebral vessels, and still more rarely there may be a gumma of the cerebral substance itself.

Diplopia is the most marked feature of the paralysis, and according to the character of the double vision it is possible to distinguish the weakened muscle, and consequently the nerve affected. When the paralysis attacks the third nerve the upper lid droops, the pupil is dilated, and the eye looks outwards (exophoria) with crossed diplopia. Paralysis of the sixth nerve causes an internal squint, and there is homonymous diplopia. When the fourth nerve is involved the patient complains of a diplopia in which the two images are inclined towards each other at their upper or lower ends, and the position of the images causes him especial trouble in such an action as walking down stairs.

Mr. Hutchinson some years ago described an interesting condition to which he gave the name of ophthalmoplegia, in which all, or nearly all, the external muscles of the eye are affected with a paresis, which may develop later into complete paralysis. The disease is usually associated with syphilis, and is always due to a lesion situated below the aqueduct of Sylvius, so that it involves the oculo-motor nerves. The nuclei of the ciliary muscle and of those of the iris escape, because they are situated farther forwards, and have a different blood-supply.

The symptoms are ptosis or drooping of the upper eyelid, with limitation of the movements of the eye in every direction, but more especially upwards. There is neither loss of accommodation nor paralysis of the iris.

Optic Neuritis.—Syphilis causes a papillitis in the same manner as it produces a paralysis of the oculo-motor nerves. The papillitis is usually a late manifestation of the disease, and it either runs a chronic course with but little impairment of vision, or it is acute with rapid loss of function on the part of the optic nerve.

The treatment of each form of syphilitic neuritis is a sufficient course of iodides. The prognosis need not be too gloomy, for the gummatous inflammation to which it is usually due often subsides, and the nerves then resume their function.

The lachrymal apparatus may suffer disturbance as a result of displacement of the puncta owing to facial paresis; to stenosis of the nasal duct due to inflammation spreading from the bones forming the nose; or from abscesses in connection with the duct itself. The patient suffers from epiphora or watery eye, which needs the treatment usually adopted in non-syphilitic forms of this condition, with removal of any diseased bone which may be present. Iodides will prove indispensable.

The Ear.—The external ear is not particularly subject to gummatous ulceration. The middle ear is most frequently affected in patients who are suffering from syphilis, owing to the extension of the inflammation from the naso-pharynx. Simple catarrh and suppurative inflammation are common during the secondary stage of the disease, whilst labyrinthine disease may lead to early and complete deafness, bone conduction being diminished from the first appearance of symptoms.

Syphilitic inflammation of the middle and internal ear runs a chronic course, and the prognosis is not very good. Mercury combined with the iodides, as well as the ordinary local treatment, may help the patient.

The Nose.—The tertiary lesions of the nose are very offensive and disfiguring. The septum nasi becomes ulcerated, and may eventually be perforated; the cartilages are especially liable to share in the inflammatory process; but in many cases the bones are widely involved, and if the vomer be deeply implicated the bridge of the nose may fall in, causing a characteristic flattening, whilst if the cartilaginous portion is involved the tip sinks and becomes flattened. Occasionally the whole substance of the nose is disintegrated, so that the nostrils are only represented by cicatricial openings. The destruction is usually a carious change; but the bone may undergo necrosis, and may be exfoliated in large pieces. The syphilitic inflammation sometimes extends to the superior maxilla, the ethmoid, sphenoid, the lachrymal bones, and even to the basi-occipital. The carious process is associated with a most stinking and abundant discharge, and with the formation of dark-coloured crusts, whilst the absorption of the poisonous products in the more severe cases leads to much cachexia.

The prognosis is fairly good in the slighter cases of syphilitic rhinitis, as the symptoms are often relieved by constitutional remedies; but it is more serious when there is evidence of caries.

Treatment.—A spray consisting of sod. bicarb. grs. xv., acid. borici grs. xv., acid. carbol. grs. iv., glycerini ♏45, et aquam ad ℥j., will often be found useful in the slighter cases of ulceration; but for deep and spreading ulcers the application of solid nitrate of silver is necessary, whilst an insufflation of iodoform powder will often assist in the healing process. Any dead bone which is loose should of course be removed, and in the worst cases careful scraping with a sharp spoon is advantageous.

Mouth and Throat.—The mouth and throat are both subject to various manifestations of late syphilis.

The tongue in particular is affected more in men than in women, and more in smokers than in those who do not smoke. The surface of the tongue presents numerous patches of altered epithelium which are at first separate, but which in time fuse together. The altered epithelium may either be thrown off, leaving the papillæ bare and raw, or it may increase in thickness, and form dry patches which become fissured. A similar condition of leukoplakia is found on the buccal mucous membrane.

The treatment consists in the administration of potassium iodide, the absolute prohibition of smoking, and a careful attention to any irregularities in the teeth which may cause irritation. The local application of chromic acid grs. x. ad ℥j., or of hyd. bicyan. grs. xv. ad ℥j. is serviceable. There is some reason to believe that the epithelial changes may progress or may be converted into epithelioma of the tongue in persons who are otherwise predisposed to cancer, and it is wise therefore to arrest the irritative process as soon as possible.

Gummata occur on the tongue and palate in a considerable number of cases, and may lead to extensive destruction by the degenerative changes which they undergo. Gummata on the tongue may be small, numerous, and superficial. They break down readily, causing small ulcers which show a serpiginous tendency. More usually the gumma is single, and lies in the connective tissue between the muscular fibres. It is usually situated far back on the dorsum of the tongue; it is painless at first, but it soon breaks down to form a small ulcer with well-defined edges.

The gummatous ulcer must be distinguished from an epitheliomatous ulcer, which is frequently grafted upon it, and from tuberculous ulceration of the tongue. The epitheliomatous ulcer is usually situated at the edge of the tongue, and the ulcer is not excavated whilst the neighbouring lymphatic glands are affected. A simple gumma heals when iodides are administered, whilst an epithelioma only improves for a few days under this method of treatment. Tubercle affects either the base or the tip of the tongue, and the ulceration is much more extensive than either the syphilitic or cancerous form. Gummata of the palate ulcerate with extreme rapidity, and a perforation is soon formed. When the hard palate is attacked, the anterior portion is generally affected; in the soft palate the pillars of the fauces often bear the brunt of the ulceration.

The treatment consists in the administration of iodides, with the addition of mercury if the patient has not already had a course.

Larynx.—The later manifestations of syphilis in connection with the larynx are ulceration, gummata, and subsequent cicatrisation with its attendant evils. The epiglottis suffers most, and the upper surface is more often attacked than the under aspect. The ulceration may occur on any part of the laryngeal mucous membrane, however, for the aryteno-epiglottidean folds, the arytenoid cartilages, and the vocal cords, true and false, are affected. The ulceration is usually deep and destructive, involving the muscles, the perichondrium, and the cartilage; but it sometimes remains superficial, with a remarkable tendency to relapse.

Symptoms.—The patient complains of hoarseness, dyspnœa, and perhaps pain shooting up to the ears. There may be great dysphagia with symptoms of œdema of the glottis, which may be so urgent as to require immediate tracheotomy or laryngotomy.

The condition has to be distinguished from tuberculous and cancerous ulceration. In syphilis the ulceration develops more rapidly than in tubercle or cancer. The ulcer is often single at first, and unilateral, deep, and irregularly oval in shape. In phthsis the progress of the ulcer is slow, and the mucous membrane is pale. The under surface of the epiglottis is most often affected, and the ulcers are numerous, bilateral, small, and round. In cancer the ulcer is preceded by the formation of a new growth, and there are nearly always nodular excrescences upon or around the solitary ulcer.

The prognosis is satisfactory as regards life, except in the cases where there is much perichondritis of the thyroid and cricoid cartilages, when death may ensue from acute œdema or from extensive suppuration.

The treatment consists locally in touching the ulcerated surfaces with a solution of sulphate of copper (15 grains to the ounce), or by the inhalation of an atomised solution of perchloride of mercury (1 : 1000); iodoform too is sometimes serviceable. A spray of carbolic acid (1 : 40) or of thymol may be used if the breath is foul-smelling. The œdema of the glottis must be treated upon the ordinary lines by scarification.

Visceral Syphilis

Trachea and Lungs.—The trachea is usually involved in syphilis by direct extension of the laryngeal inflammation, and may be followed by a very great narrowing of the lumen either along the whole tube or in its lower third.

The question of lung syphilis in adults has been the subject of much controversy. Gummata and an increased amount of connective tissue are unquestionably found in the lungs of patients who have died with other signs of syphilis. The sclerosis is found at the lower and middle lobes rather than in the apices, and it is said that the suspicion of syphilis should always attach to lesions beginning in the lower parts of the lungs and slowly progressing without the production of fever.

The Alimentary Tract.—With the exception of the mouth and rectum, the alimentary tract is but rarely affected by syphilis in its acquired form.

The rectum is liable to gummatous ulceration or to a definite fibrous infiltration beginning in the submucous tissue, and leading secondarily to ulceration of the mucous membrane, and finally to stricture.

Gummata formed in the rectum give rise to no particular symptoms until ulceration has occurred, when the patient notices that he has pain, increased after defecation, with spasm, a sero-purulent or mucous discharge, and attacks of constipation alternating with diarrhœa. Cicatrisation may take place, or an abscess may form, which ends in a fistula.

A rectal examination shows that the ulcer is generally situated within two inches of the anus, and may involve the entire circumference of the bowel. The prognosis of gummatous ulceration is that it will heal under a course of iodides, but that some amount of stricture is almost sure to follow if the ulceration has been extensive and deep.

Fibrous infiltration, or *ano-rectal syphiloma*, is much more unsatisfactory. It occurs in women more often than in men, and syphilis, I think, is only one factor in its production. At first there are no symptoms to call attention to its existence, though a digital examination, made perhaps for some other purpose, will reveal a thickened, leathery, inelastic condition of the rectal wall extending from three to five inches from the anus. A superficial ulceration of the mucous membrane occurs after a time, and extends for some distance above the indurated wall of the rectum. It is very painful, bleeds easily, secretes pus, and causes diarrhœa.

Treatment.—The gummatous ulceration is more or less amenable to the ordinary course of iodides, coupled with a thorough scraping of the ulcerated wall in advanced cases. The indurated condition appears to be hopeless when it has once obtained a firm hold of the patient. Neither mercury nor iodides are of the least service, and in the last two or three cases which have been under my care, the patient has been glad to submit to an inguinal colotomy, which has relieved her of pain and of the distressing diarrhœa, whilst it has lessened the amount of the discharge from the bowel.

Stricture of the rectum may be dilated by the use of a rectal bougie, or it may be divided *in situ* and afterwards dilated. A modification of Kraske's method is serviceable in some cases; it consists in first performing an inguinal colotomy, and then removing the strictured bowel after excising the coccyx. The colotomy wound can afterwards be closed.

The Liver and Spleen. — The liver and spleen are more rarely affected in acquired than in hereditary syphilis, but inasmuch as both organs contain a large amount of connective tissue, they are subject to the inflammatory processes characteristic of late syphilis.

The liver may be generally inflamed so that it is affected with a chronic interstitial hepatitis, or it may be the seat of gummata. In the chronic interstitial hepatitis, which leads to cirrhosis, the capsule of Glisson becomes thickened and adherent to the surrounding structures. The new connective tissue is less evenly distributed than in alcoholic cirrhosis, and the liver is consequently lobulated in an irregular manner; the lobes being separated by deep depressions due to the contraction of the scar tissue. The process is usually very chronic, but the pain is sometimes severe. It may be associated with amyloid disease or with albuminuria.

Isolated gummata are sometimes a more marked feature of hepatic syphilis than the cirrhosis just mentioned. They are found either as elevations beneath the capsule, or deeply in the substance of the organ; in the latest stages depressed scars may show where they have been replaced by fibrous tissue. The symptoms are often obscure, especially if the gummata are few and small. Ascites is somewhat less marked than in other cases of hepatitis, and there is sufficient evidence of syphilis in other organs to warrant the diagnosis.

The prognosis is not very good, but the administration of iodides must be persisted in, and they may be usefully combined with sarsaparilla.

The spleen is affected in the same manner as the liver, but much less often. The inflammation is either diffuse or localised. In the early stages of the diffuse forms the spleen is enlarged, and in this stage I have seen it become movable; in the later stages it shrinks and becomes denser than usual. The gummata vary greatly in size and number. They may go on to cicatrisation, and may cause the spleen to become adherent to the diaphragm. The splenic inflammation does not give rise to any symptoms of importance, and in the absence of other evidence of syphilis it would probably pass unrecognised.

The Genito-Urinary Organs.—*The kidneys* have been found to contain gummata from time to time, and syphilitic people suffer occasionally from the symptoms of large white kidney, but very little is known of the relation of syphilis to renal disease.

The genital organs of both sexes may be subject to gummatous inflammation during the later stages of syphilis. In the male, gummata are found on the inner surface of the prepuce, and in the urethra close to the meatus; whilst in some cases a small induration is observed in one of the corpora cavernosa, which slowly and painlessly increases in size until it seriously interferes with the function of the penis as an erectile organ. In women gummata occur in the labia, and near the inferior commissure of the vagina. More rarely they have been recognised in the vagina, where they may cause much ulceration, and have produced a recto-vaginal fistula.

The ovaries are subject to diffuse inflammation, leading to the formation of fibrous tissue. Very little is known of uterine disorders as a result of syphilis.

The testes are especially liable to inflammatory attacks as a result of syphilis. Two forms of orchitis are easily recognised during the later stages of syphilis, the smooth oval swelling and the craggy sarcocele. Either form of inflammation may be associated with a hydrocele, in some cases of the tunica vaginalis, and in others of the seminiferous tubules.

The testicle enlarges slowly and painlessly in the diffuse inflammation, maintaining its shape, but early losing sensation. The enlargement is succeeded in process of time by contraction of the newly formed fibrous tissue, with eventual atrophy of the gland. The vas deferens remains unaffected, the prostate and the vesiculæ seminales are not enlarged, and the differential diagnosis is thus made between syphilitic and tuberculous orchitis. In the craggy sarcocele the testis is the seat of gummata which lead to an increase in the size and irregularity in the shape of the testicle. The gummata may break down to form an abscess which opens by one or more openings through the scrotum, and in some cases leads to the formation of a hernia testis.

The prognosis is good in cases of syphilitic disease of the testicle. The reproductive power is not lost in the early stages, even when both glands are affected; but when atrophy has occurred the patient is sterile. Local and constitutional treatment is of the utmost benefit even when the inflammatory changes have advanced to a marked extent, for testicular inflammations appear to be more amenable to mercury and the iodides than those of any other organ except the skin.

The treatment consists in putting the patient at once upon a thorough course of iodides and strapping the affected gland with Scott's dressing. No operative measures should be recommended, for even in the worst cases the conditions rapidly improve under appropriate treatment.

Skin Eruptions.—Rupia is the name given to a characteristic eruption on the skin which appears late in the secondary or early in the tertiary stage of syphilis in people who from any cause are broken down in health. A red spot, marking an infiltration of the cutis, first appears, which afterwards suppurates, and a round pustule is formed, the superficial layer of which dries up into a scab. The suppuration continues beneath the scab, and involves more of the surrounding tissue, which in turn scabs, so that a series of concentric rings are formed, of which the central ones are thicker and higher than the outermost. The accumulation of scabs thus resembles a cone with a flat base, which has been aptly compared to a limpet shell.

The treatment is by the internal administration of mercury combined with the iodides and the local application of iodide of starch, which is made by boiling together one ounce of powdered starch, two ounces of glycerine, and six ounces of water, an ounce of solution of iodine being added when the mixture is nearly cold.

The true tertiary skin eruptions in syphilis consist of an infiltration of the skin and deeper subcutaneous tissues with gummatous material, which afterwards softens, suppurates, and

ulcerates, so that it always leaves scars, and may be extremely painful.

Gummata situated superficially in the skin show a tendency to ulcerate in a serpiginous manner, a part of the ulcer healing in one direction whilst it extends in another, so that the ulcerated surface presents an appearance like a snail-track. The leg is more often affected than any other part of the body, and next in order of frequency come the forearm and thigh, the neighbourhood of the joints showing an especial liability to ulceration, though the scars do not afterwards hamper their movements.

Gummata are also found, but less commonly, in the subcutaneous tissue, where they give rise to very chronic and troublesome ulceration. Such deep-seated gummata usually occur on the inner surface of the forearms and arms, on the breast, and on the legs. They are not of uncommon occurrence upon forehead and scalp, where serious destruction of the tissues may ensue, even to perforation of the bone. Gummatous ulceration is to be distinguished from lupus by the fact that it occurs in older people, that it shows a much greater tendency to suppurate, and that there is other evidence of syphilis. Cases have occurred in which glanders, actinomycosis, and leprosy have been mistaken for syphilitic eruptions.

The treatment in the ulcerating forms consists in the application of fomentations of biniodide of mercury, 1 in 1000, or of black wash, until the suppuration has ceased and the ulcer presents a healthy appearance, when the healing may be completed by the application of boracic ointment. A mixture containing perchloride of mercury and iodide of potassium should also be ordered for the patient.

Muscles and Tendons.—The muscles are affected in syphilis either directly or secondarily through the nerves supplying them. The primary lesions assume the form of an inflammation of the connective tissue in the muscle, either localised as a gumma or diffused throughout the muscle. The flexor muscles of the forearm, the biceps, the pectoralis major, the sterno-mastoid, the masseter, and the rectus abdominis are perhaps more often affected than the other skeletal muscles. In the diffuse inflammation the muscle becomes uneven, shortened, and irregular in outline. In the gummatous form one or more tumours can be felt in the affected muscles, usually near their tendons. The growth at first moves with the movements of the muscle, and can be felt more readily during relaxation than during contraction; but the attendant inflammation soon attaches the muscle sheath to the surrounding tissues, and there is then interference with the movement of the muscle.

Early treatment is advisable, as the inflammatory changes can then be arrested; but as the myositis often causes but little pain or inconvenience the patient may not seek advice until the gummata have begun to break down, when deep and troublesome ulcers may be formed.

The synovial sheaths of the tendons are liable to a gummatous inflammation in the later stages of syphilis, the tendo Achillis, the biceps, and the flexor and extensor tendons of the wrist being most frequently affected.

The local treatment consists in strapping the affected part, and limiting the movement in the muscle to which the tendon belongs.

Bursæ, like tendons and muscles, are the seat of gummatous inflammation, which is sometimes symmetrical, as when both the prepatellar bursæ are enlarged. The inflammation may begin in the bursa or it may spread from the surrounding tissues. Troublesome ulcers are produced if the bursæ are left untreated, and when they are subject to irritation; but the inflammation usually subsides under a course of iodides if the bursa be kept clean.

The Nervous System.—The later manifestations of syphilis in connection with the nervous system are severe and far-reaching. They depend, as in other parts, upon the production of inflammatory new tissue, which has a tendency to undergo degenerative changes at first and afterwards to be replaced by scar tissue. The anatomical peculiarities of the central nervous system lend certain features to these changes which differentiate them from similar changes in other parts of the body. In the first place the progress of the disease cannot be estimated until definite signs are produced, since evidence derived from sight and touch is necessarily excluded. The peculiarities of the terminal blood-supply and the fact that the cells of the nervous system do not reproduce themselves render comparatively slight anatomical changes of great functional importance. Syphilitic inflammation affects the central nervous system in the same way as it involves other parts of the body. Gummata more or less localised may spring from the pia mater of the brain or spinal cord. A diffuse inflammation may involve the dura mater or the pia mater, compressing the nerves and leading to the fibroid thickening known as spinal pachymeningitis. The arteries may be thickened and so diseased that the blood clots as it passes through them, or the scar tissue which is formed yields to produce an aneurysm. More rarely one of the arteries within the brain substance gives way, and the patient dies of cerebral hæmorrhage. Apart from these well-recognised conditions resulting from syphilis, there is reason to think that some forms of myelitis, and certain scleroses of the cord, such as those producing locomotor ataxy, are more or less directly connected with syphilis.

Cerebral Thrombosis.—The disease of the cerebral arteries manifests itself chiefly by an

attack of hemiplegia, due to the blocking of one of the cerebral arteries, most often the Sylvian. The attack comes on in those who are as yet too young for atheroma due to senile changes, viz. under forty-five, and without obvious cause, *i.e.* where there is no valvular disease of the heart and the patient has never suffered from any condition likely to produce endocarditis. The onset is sudden, and is seldom attended by loss of consciousness. It is often preceded by severe headache, which is either general or is felt chiefly on the side of the head which will be affected. The pain may only be felt for a few days or a week before the attack, or it may last much longer. Occasionally a slight tingling or other sensation is felt for a day or two before the onset upon the side which is to be affected. The onset therefore, although it is rapid, is not quite so sudden as when a small aneurysm on a cerebral artery gives way and blood is poured into the brain tissue. The loss of power, though it is limited at first, usually spreads to a greater or less extent, because the fibres in the large nuclei of the brain, especially in the internal capsule, which is usually affected, are packed together very closely.

Prognosis.—The attack is followed by the usual effects of cerebral thrombosis, owing to softening and destruction of the brain tissue, but the prognosis is rather better than the severity of the symptoms at the time of onset would otherwise warrant. Recovery follows the ordinary rule that the leg first regains its power, the face next, and the arm with its especially complicated movements last. During the attack the wrist, elbow, knee, and ankle reflexes are increased. The faradic response remains normal throughout the entire period of paralysis, and contractures are likely to occur though there is no appreciable atrophy. Aphasia in some of its various forms is not uncommon.

The treatment consists in relieving the progress of the arterial inflammation by the administration of iodides. As soon as the immediate symptoms have passed off, the patient should be shampooed to prevent the occurrence of contractures during convalescence.

Diffuse gummatous inflammation affects the meninges and cortex of the brain, and although it is diffuse it often presents patches of more intense inflammation, which makes it possible to localise the condition.

The symptoms come on gradually, and do not differ materially from those which characterise a meningitis due to other causes—headache, stupor, increasing coma, and perhaps localised convulsive attacks—Jacksonian epilepsy—if the motor area be involved. In many cases one or more groups of nerves are involved as they leave the dura mater, so that various paralyses occur, some of which have already been mentioned in connection with the syphilitic affections of the eye (p. 474).

Gummata, as the more localised products of syphilitic inflammation, cause definite symptoms which enable their position to be detected with considerable accuracy. Like many other forms of cerebral tumour they may give rise to an optic neuritis.

Spinal Cord.—The changes which occur in the brain as a result of syphilis take place too in the spinal cord, but in the spinal cord the meningeal inflammation is of greater importance than the arterial changes. The meningeal inflammation may begin in the membranes of the spinal cord, or it may be secondary to syphilitic disease of the vertebræ. The meningitis is often limited, and the symptoms consequently vary with the part affected, the higher the lesion in the spinal cord the more extensive being the disturbances produced.

Peripheral Nerves.—The sensory and motor nerves of the body contain considerable quantities of connective tissue, and they are in consequence no more exempt from syphilitic inflammations than other parts. The local neuritis manifests itself in various forms of neuralgia and sometimes in actual diminution of sensation, whilst paresis of one or more groups of muscles has been observed from time to time.

Parasyphilis.—Reference has already been made (p. 473) to certain conditions in which mercury and the iodides have no remedial power, though syphilis appears to be the predisposing, if not the actual, cause of the condition for which these drugs were administered. It has long been supposed that tabes and general paralysis bear some relation to syphilis, and Dr. Mott has recently brought forward a considerable body of evidence to show that in a large number of cases syphilis forms a preponderating element in their causation. In the same manner Dr. Fournier has shown that some forms of neurasthenia and hysteria are produced indirectly by syphilis. Dr. Fournier has also called attention to the peculiar condition of the skin known as *the pigmentary syphilide*, which may be mistaken for vitiligo or chloasma. The condition is found in women more often than in men, in the form of pigmented spots, patches, or networks found usually on the side of the neck, though it may occur in other parts of the body. The colour varies from a light to a deep brown, and in some cases the affected surface is covered with white specks which may lead to an erroneous diagnosis of leucoderma. Inunction with mercury may prove serviceable in removing the discoloration, but neither mercury nor iodides administered by the mouth have any apparent effect upon the pigmented patches.

Treatment of Tertiary Syphilis.—Pathology indicates the causes of the varying action of

mercury and the iodides in the earlier and later stages of syphilis; but until the pathological life-history of syphilis is fully told, the whole truth must remain hidden. It would appear that so long as the syphilitic poison is being generated in the affected body and is giving rise to actual changes in the connective-tissue elements, so long is mercury effective, for it limits the output of poison and may actually arrest its manufacture. Mercury, therefore, must always be given in the earlier stages (p. 468). Chronic inflammation in the connective tissues is due to the action of the syphilitic poison, and the inflammation in each individual falls with greatest intensity on the connective tissue in his weakest part. In some persons, therefore, the arterial system suffers most, in others the osseous system, and in others, again, the nervous system or the deeper layers of the skin. The chronic inflammation of the connective tissues may continue when it has once been started, even in the absence of fresh syphilitic poison. The iodides possess the power of causing absorption of this new and imperfect connective tissue, so long as it is cellular in character, since they have no action upon fully formed fibrous or scar tissue. This power of absorption is not limited to syphilitic fibroid tissue, for it is manifested in other forms, as in cancer and actinomycosis. The term absorption is merely a convenient one, because as yet we do not know how the iodides act upon the newly formed connective-tissue cells to cause their disappearance. From time to time the tissues appear to regain the power of manufacturing fresh supplies of syphilitic poison, and it is sometimes advantageous to give mercury and iodides together. For this purpose the draught known at St. Bartholomew's Hospital as Paget's mixture is convenient and efficacious. It consists of liq. hyd. perchlor. one drachm; caramel, a sufficiency; iodide of potassium, five grains; and chloroform water, a fluid ounce. The draught contains about one-tenth of a grain of the red iodide of mercury, and is given three times a day. The iodide of potassium is usually given, but it may be advantageously replaced in many cases by iodide of sodium, or iodide of ammonium, or each salt may be combined with the others. A little carbonate of ammonium increases the good effects of the drug. The ordinary dose of the iodides is five grains, to be increased rapidly to ten or fifteen grains, three times a day. Much larger doses are sometimes required, so that patients are frequently ordered forty-five to sixty grains thrice a day, to be taken for long periods of time. In such cases it is convenient to administer the dose as a drink in some effervescing water to be taken just after each meal. The iodides seem to act more efficaciously when they are administered with large quantities of sarsaparilla—the essence of Zittmann's treatment (p. 471)—or with guaiacum. It should be clearly understood, however, that in Europe neither of these drugs has any curative effect upon syphilis at any stage, though guaiacum was used by the native races of America for the cure of syphilis, and from them was introduced into Europe in the fifteenth century as a reputed powerful anti-syphilitic. It has not, however, withstood the test of time or of advancing knowledge.

As mercury produces a series of symptoms known collectively as salivation from the most prominent sign, so the administration of the iodides may produce a train of symptoms called iodism. The most common symptoms of iodism are loss of appetite with gastro-intestinal disturbance, and a metallic taste in the mouth with coryza, lacrymation, tinnitus aurium, and a pustular eruption which in severe cases may be purpuric. A few patients present a remarkable idiosyncrasy, for minute doses of the iodides will produce these symptoms; whilst others can take large doses without showing any symptoms of poisoning.

The use of iodides should not be continued for an unduly long period, as there is reason to believe that the tissues become habituated to the presence of iodine. The course of treatment should be interrupted, therefore, from time to time, and the patient should be ordered a tonic mixture, containing iron and nux vomica or strychnia and dilute phosphoric acid.

Various sulphur baths have been highly extolled in the treatment of syphilis, the most frequented being those at Aix-la-Chapelle, Aix in Savoy, and Luchon. There is, however, no reason to suppose that these or any other baths can eliminate the syphilitic poison, though they may benefit the general health of the patient and thus put him into a better position to withstand its effects.

As a broad rule, a person who has had syphilis remains immune to the disease for the rest of his life, and this applies to individuals who contracted the disease during or just after their birth. In very rare cases reinfection may occur, either because the patient has been completely cured after the first attack, or because, for some reason as yet unknown, he is peculiarly liable to the disease.

Relation of Syphilis to Life Insurance.—There is no evidence to show that syphilis if it be well treated materially shortens the life of the patient. Dr. Salomonsen, who has recently considered the relation of syphilis to life insurance, thinks that the patient should be kept under observation for four or five years after the initial lesion; that the premium should be increased for the next four or five years; but that if the patient has been well treated and is in good health ten years after the date of infection, he may safely be passed at the ordinary rates for his age.

Syphilis in Children

A child may be born syphilitic because the disease was transmitted to it at the time of its conception, or because the mother was infected during the earlier months of her pregnancy. It may acquire syphilis at the time of its birth by passing along a recently infected puerperal tract, or it may become infected from extrinsic sources either shortly or at a more remote period after its birth.

Hereditary syphilis, as its name implies, is derived from infection transmitted to the child from its father, its mother, or from both parents. It differs in many respects from acquired syphilis, and from a practical standpoint chiefly in the lesser power of transmitting the disease. In syphilis acquired at or shortly after birth it may be possible to obtain evidence of the seat of inoculation, but whether such evidence is or is not forthcoming the child is capable of transmitting the disease in the same way and by the same means (p. 459) as an infected adult.

Much interest has been aroused as to the means by which syphilis is transmitted hereditarily, but there seems to be no reasonable doubt that the semen of a man affected with syphilis in its earlier stages is capable of transmitting the disease to a healthy ovum at the time of fertilisation without infecting the woman who produces the ovum: conversely, a woman suffering from syphilis in its early stages will produce an infected ovum which may be fertilised by a man who is himself free from syphilis. In either case the product of conception may be syphilitic. But it is not necessarily syphilitic in the ordinary acceptation of the term, for clinical evidence shows that healthy children are sometimes born when one or other of the parents is suffering from syphilis in its active stage. These children are to a certain extent immune to syphilis, the immunity being conferred by the mother and not by the father. This fact was elicited by Guiseppe Profeta, and is now known as *Profeta's law*. He stated in 1865 that a healthy child born of a syphilitic mother could be suckled by her or by a syphilitic wet nurse with impunity. The immunity of such children is only temporary, however, and they may acquire syphilis later in life, and may then suffer as severely as those who have not been protected. In like manner a syphilitic child born of a mother who has shown no signs of syphilis will not infect its mother though it may transmit syphilis to other persons. This fact, known as *Colles'* or *Beaumès' law*, was recognised by Abraham Colles in 1837, who made the following statement:—"I have never seen or heard of a single instance in which a syphilitic infant (although its mouth be ulcerated) suckled by its own mother had produced ulceration of her breasts; whereas very few instances have occurred where a syphilitic infant had not infected a hired wet nurse, and who had previously been in good health." Both Profeta's and Colles' laws are somewhat too absolute, for, like all generalisations in pathology, exceptions have been observed from time to time.

There is no definite limit to the time when a parent is able to transmit syphilis to the child. It is usually said that five years after infection a father is unlikely to propagate syphilis, and that he is less likely to do so if he has undergone a mercurial course than if he has remained untreated. But cases are recorded where a syphilitic child has been born as long as twenty years after the father's inoculation, and it is notorious that syphilitic children may be born in spite of all treatment of the parents. It is advisable, therefore, to dissuade a man from marrying until the expiration of five years after infection, but as this advice will only rarely be taken, the general rule is to forbid a patient to marry until he has been free from any manifestation of active syphilis for at least three months. He should have been thoroughly treated with mercury (p. 468), and from the time of her marriage his wife should also be put upon a mercurial course.

Abortion or intrauterine death occurs in a considerable number of cases of inherited syphilis, and more often when the mother or both parents are affected than when the father alone transmits the disease. Abortion usually occurs about the sixth month, and somewhat later in each succeeding pregnancy in a woman who is well treated, both therapeutically and hygienically, until, in due course, a living and healthy child may be born. An examination of the still-born children will always demonstrate the presence of syphilitic lesions in the skin, viscera, bones, or nervous system. The fœtus is often macerated, the spleen and liver are enlarged, the intestines may be matted together by the products of an intrauterine peritonitis, and the bones may show evidence of epiphyseal inflammations.

Early Signs and Symptoms.—Children born alive with symptoms of inherited syphilis are often the subjects of gastro-enteritis, and from the beginning are but too often the "wasters" who are such familiar objects in the wards and out-patient rooms of every children's hospital. Such children show in a more advanced condition the various signs of syphilis found in the still-born infant. More often, however, a syphilitic child is well nourished at birth, and may remain in apparent health for a period of three weeks to two months, though examination of the spleen will usually show some enlargement. The baby then begins to pine until it may be so emaciated that the skin becomes loose and shrivelled, and it looks like a wizened old person. These children were some of the "changelings" of whom our folk tales are so

full, and whose existence excited so great a horror amongst our ancestors that no baby was left unattended for a moment until it had been safely christened, a ceremony which was thought to place it out of the power of the good people.

Snuffles is one of the earliest signs of inherited syphilis. It is caused by a swelling of part of the mucous membrane of the nose, and is often considered to be merely a cold in the head. The condition is only important from a diagnostic point of view if other signs of syphilis appear, for it is easy to attach undue importance to this sign, and there is some tendency to put a baby on a course of grey powder when it has really only suffered from a nasal catarrh. The snuffles in syphilis lasts for a long time, and may cause some broadening at the root of the nose which may persist throughout life, but more often disappears with the growth of the face.

Skin.—A rash appears soon after the snuffles have been observed. It may be erythematous, papulo-squamous, or more rarely roseolous like that which is common in acquired syphilis. Dr. Radcliffe Crocker describes the rash in the following words:—"It consists of erythematous patches of various sizes, which usually commence on the buttocks and round the anus. They may be well- or ill-defined at the edge, bright coppery or yellowish-red, tending to coalesce into large sheets of eruption, but generally patchy at the borders. This erythema may extend uniformly on the back and inner sides of the legs, quite down to the feet, including the soles, which are bright red and peeling. On the front and outer side it is still generally patchy, upwards it often extends to the loins and abdomen, and in a few cases all over the body in patches which coalesce; the whole surface is then red and desquamating on the dry parts, while on the buttocks, or where it is exposed to moisture, the scales are soaked off and the surface is left raw or brightly glistening. These generalised cases are very likely to die."

The papulo-squamous rash consists of round superficial patches, slightly raised, with a pink or reddish brown colour at first, which soon becomes of a pale fawn tint. It may be limited to one or more regions, such as the limbs, forehead, or round the mouth. But sometimes it occupies the whole surface of the body, usually in discrete patches, and occurs on the buttocks, where superficial ulceration is apt to occur. Dr. Crocker also describes a crescentic squamous variety of this eruption as well as a vesicular form. Any of these rashes may become pustular, and bullæ are not uncommon on the palms and soles.

Bones.—The bones show various changes during the first six months in the life of a syphilitic baby. The most important and frequent are the epiphyseal changes in the long bones, which occur most often at the lower end of the femur, in the bones of the legs, forearms, and ribs; more rarely in the phalanges of the fingers and toes, where the condition is known as syphilitic dactylitis. The earliest epiphyseal change occurs in several bones, and is due to a proliferation of the cartilage cells with an increased calcification but delayed ossification. The proliferation of the cartilage cell interferes with the blood-supply, and the cells therefore undergo degenerative changes which result in the formation of a yellow or orange line in the intermediary cartilage, sometimes with separation of the epiphysis. This yellow degeneration may occur within the first week or two of life, and is often associated with periostitis. A little later, a child who has been born apparently healthy may show, within the first three months of its life, a gelatiniform degeneration of the intermediary cartilages. This form of degeneration affects the arm more often than the leg, and, unlike the rickety deformity, is asymmetrical. It is sometimes associated with a condition of pseudo-paralysis, in which one or more of the limbs lie cold, wasted, and flail-like. The pseudo-paralysis is due to a myositis in some cases, and to a peripheral neuritis in others.

The bones of the skull are peculiarly liable to local periostitis during the earlier months of life in syphilitic children, the inflammation being often symmetrical, and occurring on the frontal and parietal bones close to the anterior fontanelle, where they form Parrot's nodes, and cause the skull to be described as "natiform" or "hot cross bun-shaped." Syphilitic children are often rickety, but there is no reason to think that the nodes here described are syphilitic rather than rachitic in origin. They usually disappear during the first year, and leave no trace of their existence.

Viscera.—The viscera are early affected by syphilis, and Dr. Coutts says that in 100 cases of inherited syphilis under his care the spleen was enlarged in 62, and in 19 others its size was probably above the normal. The splenic enlargement, he thinks, dates from birth, and may certainly exist before any other symptom of inherited syphilis has manifested itself. It is due to a simple multiplication of the normal cellular elements, and not to the formation of gummatous tissue. The liver is also affected in many syphilitic babies, the changes being those of an interstitial hepatitis. The jaundice is not usually a marked feature of the condition.

The mucous membranes are not markedly or early affected in the subjects of hereditary syphilis, though specific ulcers and mucous tubercles are found in the mouth and about the anus.

The Eye.—Iritis occurs in an early stage of inherited syphilis, and it is very likely to be overlooked, partly because it is rare, and partly because it does not cause any very acute

symptoms. It usually appears within the first six months of life, is plastic in type, and occurs in both eyes. Adhesions are often formed between the iris and the capsule of the lens, but there is neither keratitis nor choroiditis in the earlier stages. The inflammation responds readily enough to ordinary antisyphilitic treatment.

Choroiditis occurs in the eyes of very young children, the subjects of inherited syphilis, often in association with manifestations of cerebral syphilis. The ophthalmoscope shows small flecks of exudation of a brownish colour, and apparently situated in the choroid; there is often but little disturbance of pigment, and no atrophy either of the choroid itself or of the optic disc, and the vessels of the fundus are altered in outline as a result of endarteritis. The condition may therefore be distinguished from the tuberculous choroiditis in which there are large, round, well-defined, and milk-white spots to be seen in the choroid—a distinction which is of very great importance from a diagnostic point of view, and consequently for treatment.

The Nervous System.—The brain and spinal cord with their meninges are subject to the same syphilitic changes in infants as in adults. A chronic inflammation of the membranes of the brain may occur even during intrauterine life, and may lead to a thickening of the dura mater. The chronic meningitis may or may not be associated with hydrocephalus; the child often has convulsions, and may be an idiot. It is sometimes correlated with inflammation of the cerebral substance, which may become sclerosed and even calcified.

The cerebral arteries in syphilitic infants are subject to the same arterial changes as in adults with acquired syphilis. The endarteritis causes thrombosis, and may lead to hemiplegia, softening of the brain, and idiocy.

Later Symptoms.—Few diseases clear up so rapidly and satisfactorily as hereditary syphilis in young children, but few relapse so completely when the treatment is discontinued, and even in some cases in spite of treatment. Recurrence takes place as a rule during the second year, perhaps because the difficulties of teething have weakened the child, but it may be delayed for a longer period, and even until the changes at puberty reawaken any latent taint which may have existed.

The earliest symptoms of recurrence are usually associated with the mucous membranes. Sores may be developed at the angles of the mouth, and mucous tubercles may appear wherever there is a combination of moisture, warmth, and friction. True condylomata are sometimes formed, but they are much commoner in children who have acquired syphilis than in those who are the subjects of the inherited disease.

The bones suffer equally with the mucous membranes. Round and semi-fluctuating swellings are developed on the skull, especially upon the frontal bones, as well as upon the tibiæ and phalanges. The swellings are due to a gummatous periostitis, and usually disappear under appropriate treatment, but necrosis of the underlying bone may take place if they suppurate. A similar inflammation of the palate produces widespread destruction within the mouth; whilst the mucous membrane of the nose is liable to undergo extensive inflammatory changes which may involve the bones and cartilages, leading to the depression of the bridge which is thought by many to be one of the characteristic features of early syphilis.

Gummata are occasionally seen in the *skin*, but they are less common than in the children who have acquired syphilis, and they are much less easily cured by mercury.

The testes, and perhaps the ovaries, are affected by diffuse inflammation in some cases of hereditary syphilis. The body of the testis is generally affected, but the epididymis does not always escape. There is often a loss of, or diminution in, the sexual characteristics in persons who have been the subjects of hereditary syphilis, and it is thought that this alteration may perhaps be due to the changes occurring early in life in connection with the ovaries and testes.

Ear.—Deafness is an important complication of hereditary syphilis. It may begin suddenly at any age from infancy to adolescence, sometimes without warning, and with continuous subjective noises, due apparently to pathological changes in the labyrinth. Unhappily, very little can be done to cure this form of deafness, which may lead to deaf-mutism when it occurs before the child has learnt to talk.

The latest signs of hereditary syphilis appear in the eyes, teeth, joints, and nervous system.

The Eyes.—Inflammation of the cornea is one of the best recognised amongst the later manifestations of hereditary syphilis. It is an interstitial keratitis, which may begin at any age between five years old and five-and-twenty, though it is most common about puberty. It may occur in those who are apparently in good health, and who have long been free from any sign of inherited taint. One eye first becomes irritable, and the cornea hazy, and after a time the other eye becomes affected in a similar manner. The corneal patches increase in size until the cornea becomes opaque like ground glass, and the patient is blind for all practical purposes, though he never loses perception of light. The inflammation is attended by a circumcorneal zone, due to congestion of the ciliary region, but there is very little conjunctivitis. The pain may be slight or severe. Sooner or later the corneal opacity becomes salmon-pink in parts, due to the ingrowth of

minute blood-vessels, and from that day the opacity begins to disappear, though the process is very slow, and the entire attack may take a year before it completely passes off.

The prognosis is good, and the patient can be buoyed up with the hope that he will almost certainly recover the greater part of his former vision, even when both eyes are affected severely, and he is nearly blind.

Retinitis.—Later in life, *i.e.* about the age of twenty-one, patients, and men more often than women, may present evidence of retinitis. Ophthalmoscopic examination shows the retina to be dotted yellowish-white, the veins are enlarged, and pigmented spots are seen chiefly in the equatorial region. There are central or annular scotomata. The colour sense remains normal as long as the disc shows no sign of atrophy. The retina is occasionally detached.

The permanent teeth show remarkable changes in the subjects of hereditary syphilis, especially in those who have interstitial keratitis. The changes are thus described by Mr. Jno. Hutchinson, who first drew attention to them :—

"At or after the age of puberty the recognition of the subject of inherited syphilis may sometimes be made with great certainty; at other times it is surrounded by difficulties. Our most valuable aids are the evidences of past disease, more especially of inflammations which may have occurred in infancy. A sunken bridge of the nose caused by long-continued swelling of the nasal mucous membrane when the bones were soft, a skin marked by little pits and linear scars, especially near the angles of the mouth, the relics of an ulcerating eruption, and protuberant frontal eminences consequent upon infantile periostitis, are amongst the points which go to make up what we recognise as an heredito-syphilitic physiognomy. Added to them we have very valuable aid furnished by the shape of the incisor teeth. In these patients it is very common to find all the incisor teeth dwarfed and malformed. Sometimes the canines are affected also. These teeth are often narrow, rounded, and peg-like; their edges are jagged and notched. Owing to their smallness the sides do not touch, and interspaces are left. It is, however, the upper incisors which are the most trustworthy for purposes of diagnosis. When the other teeth are affected these very rarely escape; very often they are malformed when all the others are of fairly good shape. The characteristic malformation of the upper central incisors consists in a dwarfing of the tooth, which is usually both narrow and short, and in the atrophy of its middle lobe. This atrophy leaves a single broad notch (vertical) in the edge of the tooth; and sometimes from this notch a shallow furrow passes upwards on both anterior and posterior surfaces nearly to the gum. This notching is usually symmetrical. It may vary much in degree in different cases; sometimes the teeth diverge, and at others they slant towards each other. . . . In a considerable number of cases of heredito-syphilis the teeth show no deviation whatever from the normal standard . . . and it is only in the permanent set that any peculiarities are observed. The first set are liable to premature decay, but are not malformed."

The joints are affected about the same time as the cornea, and *mutatis mutandis* they appear to undergo similar pathological changes. The knees and shoulders are most often affected. A slight synovitis involves the joint on one side, and after a time the opposite joint begins to swell. Both joints remain inflamed for a long time, and the joint first affected recovers before the other. There is no permanent impairment of function as a result of the synovial inflammation.

The worst form of syphilitic arthritis is fortunately the most rare, for it does not respond to antisyphilitic remedies and is practically incurable. It occurs about puberty, when a rarefying osteitis affects many bones and joints, and is associated with a deposit of caseating material in the cancellous tissue. A similar process taking place in the articular cartilages leads to the formation of irregular pits and grooves, and has led to the disease being described under the name of chondro-arthritis. The inflammation is marked by transient attacks of synovitis, with evidence of chronic inflammation of the bones affected. There are often other signs of syphilis, with evidence of long-standing iritis and choroiditis, and enlargement of the spleen.

The Nervous System.—There is an increasing tendency to believe that certain rare cases of tabes and general paralysis occurring about the age of puberty are parasyphilitic (p. 480) affections, even if they are not more directly connected with hereditary syphilis. Dr. Fletcher Beach says that in juvenile general paralysis there are, as a rule, no grandiose symptoms, but a steady progress towards dementia, and that the course of the disease is more prolonged than in adult cases.

Acquired Syphilis in Children.—Syphilis may readily be acquired even by the youngest children, and in a variety of ways. Local outbreaks have occurred from time to time as a consequence of arm to arm vaccination, and in the course of ritual circumcision, and although the methods leading to these sources of infection have been abandoned, many other means still remain. The lesions of acquired syphilis transmit the disease with much greater ease than those of the hereditary form, and it is important, therefore, to distinguish the one from the other. Acquired syphilis presents all the characters in children which mark the disease in adults, with certain modifications due to the tender age of the patient. There is a primary sore followed

by a rash, which is fugitive, and differs from that of the hereditary syphilis in being roseolous. Snuffles and visceral affections are rare, but condylomata and gummata of the skin are common. The later skin eruptions, especially in scrofulous subjects, present a lupoid character, and the following case of gummatous synovitis shows how easy it would be to mistake such a joint disease for the more common tuberculous form :—

A boy aged 14 came under my care on the last day of January, with an inflammation of the right knee. He had diphtheria in September, and about a month afterwards sores appeared upon his body. He was noticed to be walking lamely about the end of December. The patient's complexion was muddy, and scattered over his limbs and scalp were patches of superficial ulceration covered with thick scales or with black and raised crusts. The voice was husky, but his teeth were healthy, and there was no evidence of keratitis or iritis, either recent or remote. The glandulæ concatenatæ, at the posterior border of the sterno-mastoid muscle, were slightly enlarged on both sides. The right knee was affected with synovitis, and there was some increase of synovial fluid in the left knee. The synovial membrane in both joints seemed to be thickened, especially at the sides. The patient occasionally felt a little throbbing pain, but unless the knee was moved it had never been severe, and he had not been awakened by starting pains at night.

The boy was brought by his mother, who said that his younger brother had had one ankle-joint excised for a similar condition, which had presumably been mistaken for a tuberculous arthritis ; but she presented such obvious signs of tertiary syphilis that the patient was at once ordered one-grain doses of grey powder to be taken three times a day. In ten days' time his complexion had cleared, and he was less husky. There was also a smaller quantity of fluid in his right knee, whilst the left one was normal. The improvement continued until 7th March, when the patient was allowed to go about with his right knee in a plaster of Paris case. He returned on 26th March without the case, and complaining of much pain with increased swelling in both knees. Both joints were fixed with plaster of Paris bandages, but he again returned on 2nd April with increased swelling of both knees and some synovitis of both elbows. He then confessed that he had not taken his powders for a fortnight. The boy was made to understand that medicine was necessary to his cure, and he was ordered to continue the one-grain doses of grey powder three times a day. His elbows were less swollen and painful on 9th April, though his knees still remained enlarged. He was therefore given half-drachm doses of the solution of perchloride of mercury with five grains of iodide of potassium three times a day. A week later he returned, saying that his elbows were well, his knees better, and that he had suffered no pain since he began the new medicine. He increased in weight from 64½ lbs. on 16th April to 71½ lbs. on 30th April, and he has since remained well and at work.

Treatment.—The treatment of hereditary syphilis during the first year of life is easily summed up. It consists in judicious feeding and the administration of mercury, preferably in the form of grey powder or by inunction (p. 468). Cod-liver oil should also be given in the majority of cases. The mother should at all times suckle her own child when it is possible, and there is the additional reason in the case of hereditary syphilis that the child is born weakened, and with its digestive and assimilating organs in an unhealthy condition. But if such a child has to be bottle-fed, more than ordinary precautions must be taken to keep the bottle clean and the food sweet and free from fermentation.

Syphilitic infants react to mercury more rapidly and much more completely than adults, and they positively thrive on grey powder given in quarter or half-grain doses three times a day. If the grey powder causes diarrhœa or digestive disturbance a piece of blue ointment about the size of a pea may be rubbed into each groin every night, or the ointment may be spread on a piece of lint which is placed over the abdomen, and is kept in place by the child's binder. From twenty to forty grains of perchloride of mercury may be dissolved in the little patient's bath with excellent effects, especially when it is suffering from a rash. The mercurial course should be continued for at least six weeks after the last signs have disappeared, and by this means slight cases can often be cured completely within the first eighteen months after birth.

The later manifestations of syphilis, whether hereditary or acquired, are best treated with a combination of mercury and the iodides, and the treatment should follow the general lines recommended for adults.

Syphilis, Recent Advances in the Knowledge of.

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Causal Agent of Syphilis.—The spirochæte pallida. On 17th May 1905, Schaudinn and Hoffmann communicated to the Medical Society of Berlin their discovery in syphilitic lesions of a spirochæte, and it is at present almost universally held that in doing so they solved the problem of the etiology of syphilis. In the early part of the same year Siegel described as the specific cause of the disease a protozoon-like organism, which he called the *cytorrhyctes*

luis; and although the correctness of his observations was soon disproved, it was their impetus which induced Schaudinn, endowed as he was with special skill and experience in protozoology, to tackle the question afresh. It is also interesting to note that although the whole credit of the discovery rests with Schaudinn, it was by mere accident that he was not anticipated by Bordet and Gengou. About two years before, they found a spirillum (which was in all probability the spirochæte pallida) in smears from a hard chancre, but did not fully appreciate the significance of their discovery; while Metchnikoff, failing either to verify their observation or to find such spirilla in the experimental syphilis he had recently succeeded in producing in apes, declared against syphilis being a spirillosis.

Following closely on the heels of Schaudinn's account of his work, came a report from Metchnikoff that his infected monkeys showed a spirochæte resembling (and soon identified by the German protozoologist as identical with) the new organism. Thus within a few days were two important facts made public—its occurrence in the lesions of the disease in man, and its existence in animal infection. A further link in the chain of evidence was soon supplied by Buschke and Fisher, who demonstrated the same spirochæte in the organs of a congenital syphilitic infant, and Levaditi, who detected it in the fluid of the bullæ of congenital syphilitic pemphigus. In the former site, at least, a saprophytic parasite was unlikely. Since that time, observations all over the world have led to the same results. The spirochæte pallida is found in the primary sore, in the enlarged glands, in the secondary lesions, in the blood stream—and it has never been found except in syphilis. It has been found in the saliva, in the urine, in the ovaries, but not in the cerebrospinal fluid, nor, curiously, in the semen. It has even been detected in tertiary lesions, but not in parasyphilitic diseases—tabes and general paralysis. It is abundant in all the organs, including the bones, of syphilitic fœtuses; in the umbilical cord; in the placenta.

Part of Schaudinn's work was to differentiate the varieties of spirochætes which occur in healthy and diseased genital organs. He showed that there are two—the *spirochæte refringens*, a normal saprophytic denizen, and *spirochæte pallida*, in syphilis only.

Characters of Spirochæte Pallida.—It is a very delicate spiral organism, with an average length of 6 to 16 μ, smaller and larger individuals being also met with. It consists of from 6 to 26 delicate spiral undulations, each measuring from ·8 to 1·6 μ. Its diameter is about ·7 μ. The organism retains its spiral form when at rest. An undulatory membrane has not been demonstrated, and the existence of a nucleus is doubtful. The peripheral part is thinned out at each end to form a delicate flagellum. Schaudinn was able to observe that fission took place by longitudinal division, beginning with the formation of two flagellæ at one pole. The spirochæte pallida is capable of backward or forward motion by corkscrew-like rotation round its longitudinal axis; in addition to this, undulations course along its whole structure. Motility is retained for several hours in salt solution, but is lost in glycerine; the organism rapidly dies when deprived of moisture. S. refringens is a larger organism which stains more deeply and has more open undulations. With a little experience it is not difficult to distinguish it from s. pallida.

Technique of Detection.—Spirochætes should be sought in the deeper parts of lesions. The surface of a Hunterian chancre should be thoroughly washed with soap and water, gently scraped, and smears made from the fluid which exudes. Surface contamination with s. refringens is thus avoided. Another plan is to apply a vesicant to the skin, and to examine the serum; another, to puncture a bubo with a syringe. The tissue juices from cases of hereditary syphilis sometimes swarm with the organism. Spirochætes are visible in fresh smears; they do not stain deeply; they are more difficult to recognise in sections than in film preparations.

In examining fresh preparations incandescent gas is preferable to day or electric light (Metchnikoff). The ultra-microscope (dark ground illumination) shows the organism readily. For staining films, Giemsa's stain is usually employed. Fix air-dried films in absolute alcohol for 1 hour, and immerse them for 24 hours in dilute stain (15 drops to 10 c.c. distilled water). Spirochætes are stained pale violet, and nuclei deep red. Giemsa's stain (Grübler and Co.) is composed of azur II. ·8 gram, azur II.-eosin 3 grams, glycerine (Merck's chemically pure) 250 grams, methyl alcohol (Kahlbaum I.) 250 grams. For sections, von Ermenghem's method is used, though exception has been taken to the use of a reduced silver process on account of the liability to confusion between the organism and fibrillæ of the tissues. Sections are placed for 24 to 48 hours in ·2 to ·5 per cent nitrate of silver solution, rapidly washed in distilled water, and immersed for $\frac{1}{4}$ hour in gallic acid 5 grams, tannin 3 grams, sodium acetate 10 grams, distilled water 350 c.c., until they are tinged yellow. They are then replaced in the silver solution until they turn brown, and are washed and mounted as usual.

Biology.—The exact position of the spirochæte is still uncertain. Schaudinn, whose untimely death cut short his researches and robbed science of so brilliant a worker, inclined to the view that it was a trypanosome, but this is still quite uncertain. He rechristened it "spironema" and then "treponema pallidum," but

probably it will continue to be known best as spirochæte pallida until its exact relationships are ascertained. For the present it is best simply to regard it as one of the protista. A good general account of spirochætes will be found in *Science Progress*, July 1908.

In the body, the spirochæte enters the vessels and lymphatics and is found in the blood stream. Its chief predilection is for the walls of the lymphatics, whence it enters the intercellular and interfibrillary spaces of the tissues. It is found especially in connection with mononuclear infiltrations, and Metchnikoff believes that it exerts a chemotactic influence on these cells. It undergoes phagocytosis at their hands, and perhaps by the glandular and epithelial cells also. Nothing more is known as to its life-history.

It is evident that there is likelihood, verging on certainty, that *s. pallida* is the cause of syphilis. Its almost constant presence in the lesions of acquired syphilis, and its absence from those which are not syphilitic; its presence in experimental syphilis in apes; its abundance in the viscera in congenital syphilis—seem to exclude its being a saprophyte. The facts that the organisms disappear under efficient treatment, that, like the virus, they do not resist drying, that they are absent from fluids which are not infectious (cerebro-spinal fluid) and present in those which are (saliva), point in the same direction. That they have escaped recognition in the semen is remarkable, while the failure of attempts to cultivate them outside the body renders the fulfilment of all Koch's postulates an impossibility.

In the disease yaws, which bears so much resemblance to syphilis, Castellani discovered a spirochæte (s. pertenuis) which is very similar to s. pallida (*see* "Parasites," vol. vii. p. 344).

Serum Diagnosis of Syphilis.—Wasserman has lately introduced a method of serum diagnosis for which it is claimed that a positive result is conclusive: negative reactions have no evidential value for or against. The test is applicable to all stages of the disease, and to parasyphilitic maladies as well. The method is complicated, and can only be applied by an expert, hence reference to it will be brief. It depends on what is known, in the language of immunity, as "fixation of the complement." If an animal A be injected with the red corpuscles of another species B, A's serum acquires the power of lysing B's corpuscles *in vitro*—it has become an immune serum. If A's serum is heated (inactivated) it loses this power, which, however, is restored to it when normal fresh serum containing complement is added (*see* art. "Immunity," vol. iv. p. 370). Thus three substances are concerned in hæmolysis—corpuscles, amboceptor (in the inactivated immune serum), and complement (in the normal serum): these make up a hæmolytic system. If, instead of normal serum, syphilitic serum is the complement-containing partner in such a hæmolytic system, and if before adding it we can by any means "fix" its complement in another combination so that it will not be available to unite with the hæmolytic immune body, lysis will not occur. In effect, this is Wasserman's reaction. To a mixture of red blood corpuscles and inactivated serum, the serum of the suspected patient is added. Before addition, however, it is treated with an extract of a syphilitic liver which contains antigens. Should the serum in question be syphilitic also, the antibodies in it will combine with these antigens, and in doing so will fix all the complement, so that none is available to complete the hæmolytic system. A positive result, therefore, is constituted by absence of lysis. As in all such observations, a number of controls are required for each test.

Syphilo-.—In compound words *syphilo-* means relating to or belonging to syphilis; e.g. *syphilogeny* (origin of syphilis), *syphilomania* (insane dread of syphilis), *syphilonychia* (onychia of syphilitic origin), and *syphiloma* (a gumma).

Syphon.—A tube bent at an angle in the shape of an inverted ∩, one arm, however, being longer than the other; it is used for transferring fluids from one vessel to another (as in the syphon water-closet), from a vessel to a part of the body (as in the syphon vaginal douche), or from a body cavity to a vessel (as in the syphon aspirator).

Syringe or Syringa.—An apparatus of the nature of a pump (Gr. σῦριγξ, a pipe) for injecting or drawing off fluids; *e.g.* a hypodermic syringe, an ear syringe, or an aspiratory syringe; in a special sense, the Eustachian tube. *See* Aseptic Treatment of Wounds (*Hypodermic Syringes*); Diphtheria (*Treatment, Roux's Syringe for Serum*); Ear, External, Diseases of (*Ceruminous Obstruction, Treatment*); Prescribing (*Administering Drugs by Injection through the Skin*); Tetanus (*Treatment, Injection of Antitoxic Sera*).

Syringitis.—Inflammation of the Eustachian tube. *See* Ear, Middle, Chronic Non-suppurative Disease, etc.

Syringo-Cystadenoma.—A cutaneous disease originating probably in the embryonic sudoriparous glands, and characterised by the appearance of numerous small, round, hard papules, white at first but becoming bluish red later. *See* Skin, Diseases of Sweat and Sebaceous Glands.

Syringomyelia.

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See also Acromegaly (*History*); Chest, Deformities of (*Shape of Chest in Syringomyelia*); Deformities (*Deformities arising from Spinal Paralysis*); Hand (*Appearances in Syringomyelia*); Joints, Diseases of (*In Syringomyelia*); Nails, Affections of the (*Diseases of the Nervous System*); Osteo-Arthropathies (*In Syringomyelia*); Paralysis (*Chronic Nuclear Bulbar Paralysis, Diagnosis*); Spinal Cord, Medical (*Anatomical, Central Canal*); Spinal Cord, Medical (*Pathological Considerations, Congenital Cavities in Cord*); Ulcers and Ulceration (*Perforating Ulcer of the Foot*).

Definition.—The term syringomyelia is applied to a chronic progressive affection of the spinal cord, which is characterised by the presence of cavities and by proliferation of the glial tissue in the neighbourhood of the central canal. The origin of the disease finds its almost certain explanation in some anomaly of development, although it seems probable that additional factors are necessary for its production. The most striking clinical features of the disease are:—(1) A peculiar disorder of sensation, in which there is loss or diminution of the perception of painful and thermal sensations, with little or no impairment of the tactile sense; (2) various vasomotor and trophic disturbances in the bones, joints, and skin; and (3) progressive muscular wasting, most frequently affecting the upper extremities. Not unfrequently there is some degree of spastic paraplegia; scoliosis and kyphosis are often present; bulbar symptoms are not uncommon, and may be unilateral; diminution in the size of the pupil and narrowing of the palpebral fissure on one or both sides are frequently met with; the deep reflexes are almost always altered; disturbance of the functions of the bladder and rectum seldom occurs, excepting in the later stages of the disease.

Historical.—Ollivier (1827) introduced the expression syringomyelia (σῦριγξ = pipe, tube) to denote all canals or cavities in the spinal cord. The presence of cavities in the cord had, however, been noted from time to time for many years previous to this. The occurrence of symptoms, muscular atrophy, etc., in cases presenting the anatomical condition of syringomyelia was first drawn attention to by several observers in the middle of last century. Kahler and Schulze, working independently, pointed out in 1882 that it was possible from the character of these symptoms to diagnose syringomyelia during life. In consequence of this discovery great attention has been paid to the disease, and contributions to its literature have been very numerous. Of these, the monographs of Blocq (1890), Hoffmann (1893), and Schlesinger (1894) are probably the most important. A second and greatly enlarged edition of the latter work has recently appeared (1902).

Frequency of the Disease.—In this country syringomyelia is a rare disease. On the Continent it appears to be much more common. Schlesinger has personally observed 120 cases, and has had more than 30 post-mortems. This author makes the following remarkable statement (*Syringomyelie*, 1902, s. 266):—"In my opinion syringomyelia, or central gliosis, is one of the most common of the spinal cord diseases, and ought, as regards frequency, to follow closely tabes and the syphilitic and pressure paraplegias." A few lines lower down he adds that the disease is more often met with than multiple sclerosis, a statement which does not hold good in this country.[1]

Pathological Anatomy.—A reference to some facts connected with the development of the spinal cord will aid the elucidation of this subject.

At a certain stage of fœtal development the central canal of the spinal cord exists as a fissure-like cavity between the posterior columns. At a later date the posterior columns coalesce anteriorly, forming by their union the posterior commissure which separates the *true* central canal from the rest of the cavity lying posterior to it. As development proceeds, the latter cavity is gradually obliterated by a fusion of the posterior columns from behind forwards. But an arrest of development may take place before this obliteration is complete, in which case the cavity persists into adult life. Should development have been arrested before the formation of the posterior commissure, this cavity will be seen to include what would ultimately have become the true central canal.

The neuroglia of the adult spinal cord originates from embryonic cells which surround the central canal of the fœtus, and which in post-natal life lose their propagating qualities. Where development has been arrested, the embryonic cells which surround the fœtal central canal do not disappear, but are to be found as a thick sheath surrounding a dilated canal produced in the manner already described. This is the condition which we term hydromyelia, a pathological state unaccompanied by symptoms.

Under certain circumstances the persistent embryonal tissue above referred to possesses the property of proliferation. By its proliferation a *new formation* is produced which may cause considerable local enlargement of the

[1] During the years 1896-97-98 there were admitted to the National Hospital, Queen Square, W.C., 2568 cases of "nervous disease," of which 159 were diagnosed as disseminated sclerosis, 11 as syringomyelia (cf. Registrar's Annual Reports).

cord. We apply the term syringomyelia to this condition, *i.e.* the occurrence of cavities in the cord associated with a *new formatiom* derived from the embryonic glial cells.[1] Syringomyelia is a further stage of hydromyelia; it is a progressive as opposed to a stationary condition. Whether a hydromyelia is capable at any time of taking on active growth and becoming a syringomyelia, we cannot say.

The spinal cord in cases of syringomyelia usually presents very obvious pathological changes to the naked eye. The membranes generally appear healthy, but there is sometimes considerable thickening of the dura, especially in the cervical region. Where there is extensive cavity formation, which is often the case, especially in its upper part, the cord is flattened from before backwards and feels soft and fluctuating. In places it may be greatly reduced in calibre, and may be no larger than that of a young child, while in regions where there is true tumour growth it may be considerably increased in size. Similarly, the medulla is sometimes much flattened. It, too, may appear smaller than normal. The diminution in size is often more pronounced in one half of the organ than in the other. The aqueduct of Sylvius is sometimes greatly dilated. A condition of internal hydrocephalus, with thinning of the surrounding brain substance and flattening of the convolutions, is occasionally present.

The spinal cord on transverse section may present very different appearances according to the level at which the section is made. The presence of one or more cavities in the substance of the cord is often the most striking feature. It is most usual to find one cavity, more or less centrally situated, and lying posterior to the central canal, with which it is sometimes seen to be in direct communication. The cavity may be so large as to occupy the greater part of the transverse section, in which case it is surrounded merely by a thin tube of tissue; it may, on the other hand, be so small, that it is only recognisable with difficulty by the unaided eye. All gradations exist between these extremes. In some cases the cavity extends out through the whole length of the cord, from the filum terminale into the medulla; in others it is much more limited in extent; not uncommonly it is confined to the lower cervical and upper dorsal regions of the cord.

The wall of the cavity is usually smooth, and is composed of a layer of translucent embryonal glial tissue. It varies greatly in thickness, and its inner surface is covered by epithelium. The contents of the cavity vary; sometimes they consist of a clear fluid; in other cases the fluid is turbid, and it may have a brownish colour from recent hæmorrhages.

The embryonal glial tissue, which has been above referred to in describing the wall of the cavity, consists of a network of neuroglial spindle cells and fine fibres in varying proportions. It may extend through the whole length of the cord. Its transverse extent varies at different levels. In some sections it is seen to surround a central cavity. It sometimes forms distinct tumours, causing considerable enlargement of the cord, and surrounded merely by a narrow ring of cord tissue. Cavities are often to be seen in the substance of this new formation; they have been produced by a breaking down of the tumour tissue. From what has been said regarding the development of the central canal, these various appearances will be readily understood.

In some cases an increase of the blood-vessels of the cord has been described; thickening of the vessel walls has been noted in a few instances. Ascending and descending degenerations are often to be seen in the white matter of the spinal cord. Degenerative changes in the peripheral nerves have been described by Hoffmann and others.

Etiology.—Syringomyelia is essentially a disease which owes its origin primarily to a developmental defect, and it is of interest to note that developmental defects of other parts of the body are not uncommon in individuals suffering from this affection.

Syringomyelia sometimes occurs in association with spina bifida.

The disease is almost twice as common in males as in females.

The first symptoms most frequently appear during the second, third, or fourth decade, and especially between the ages of twenty and thirty.

Trauma appears to be a definitely related etiological factor in some cases.

Occasionally the symptoms of the disease have first attracted attention during convalescence from one of the exanthemata: several cases, for example, appear to have developed during recovery from typhoid fever.

Syphilis is believed by some authorities to play a part in determining the morbid process, but its influence in this respect is certainly not great.

The comparative rarity of syringomyelia in this country is of interest from an etiological point of view.

Symptoms.—The symptoms of syringomyelia depend upon the damage done to the spinal cord by the growth of the new formation, and to some extent possibly by the pressure produced by the distension of the cavity or cavities. Their incidence is determined by the part of the cord which is involved, and since this is usually the lower cervical or upper

[1] Some authorities hold that this new formation is produced by proliferation of the normal adult glial tissue, which is especially plentiful in the neighbourhood of the central canal.

dorsal region, they are commonly referable to the upper limbs and thorax. Persistence of the central glial tissue and cavity formation may be unassociated with symptoms: it is only when the glial tissue takes on active growth that they become evident.

Dissociated anæsthesia, loss or diminution of the sensibility of the skin to thermal and painful impressions with preservation of the tactile sense, constitutes a most characteristic symptom of the disease. The explanation which is advanced to account for this dissociation assumes that the fibres which carry painful and thermal impressions are more centrally situated (they probably cross in the posterior commissure) after entering the cord than those which conduct tactile impressions, and are therefore involved at an earlier date by a lesion which extends from the centre of the cord towards its periphery.

The areas of cutaneous anæsthesia to painful and thermal impressions are not always coextensive: the latter may be lost over a greater area and to a greater degree than the former. Similarly, the limits of anæsthesia for heat and cold do not always exactly correspond.[1] Very often a careful examination of the skin where there is thermal and painful analgesia will demonstrate a slight degree of tactile anæsthesia. In other regions the tactile anæsthesia may be complete.

The dissociated anæsthesia usually makes its appearance in the upper extremities or thorax. The head and face are not uncommonly involved: the lower limbs are rarely affected until the disease is far advanced. The anæsthesia is rarely symmetrical: it is almost always more extensive on one side than the other. When the face is anæsthetic a central mask, which includes the eyes, nose, and mouth, very commonly escapes. The anæsthesia is usually sharply limited. The frequency with which dissociated anæsthesia occurs as the first manifestation of the disease, and its greater extent as compared with other symptoms, *e.g.* muscular atrophy, are accounted for by the central position occupied by the fibres which conduct painful and thermal impressions.

Subjective sensations, such as pain in the back, feelings of heat and cold or of formication, etc., in the extremities, are not uncommonly complained of. Shooting pains in the arms and neck constitute a troublesome symptom in some cases.

The muscular sense, sense of position, and stereognostic sense are not usually affected to any great extent.

Muscular atrophy is one of the most important symptoms of syringomyelia, occurring in at least 50 per cent of the cases. The wasting has a distribution very similar to progressive muscular atrophy, commencing usually in the small muscles of the hand and causing flattening of the thenar and hypothenar eminences with sinking in of the interosseal spaces. The forearm may also be affected, especially the muscles on its ulnar aspect. The hand may assume a claw-like appearance, the so-called *main en griffe*. The muscles of the shoulder and upper arm are sometimes first affected, as in the scapulo-humeral type of progressive muscular atrophy. The wasting is usually much more advanced on one side than the other. As the disease spreads the muscles of the trunk and neck become involved, and later the lower limbs may waste. Occasionally the atrophy is first seen in the muscles of the lower limbs; it may be that these cases are more common than is generally supposed, for they certainly often escape recognition.

Gradual loss of power accompanies the atrophy, and fibrillary tremors are seen in the affected muscles, while changes in their electrical excitability, such as are met with in progressive muscular atrophy, more especially a diminution in the faradic response, occur.

Weakness in the legs, depending upon a certain degree of spastic paraplegia, is sometimes seen early in the disease, but is more common in the later stages. Increase of the knee-jerks and an extensor response may afford evidence of involvement of the pyramidal tracts long before there is any marked degree of weakness of the lower limbs.

A variety of *vasomotor and trophic* changes occur in the skin and its appendages. Thus the hands are often blue and cold; they may be swollen and œdematous. The skin in some places is thick and horny, sometimes it is thin and smooth. The nails are often cracked and furrowed; they may be much thickened. Bullæ, which vary in size, are often developed, especially on the upper extremities. They are filled with clear fluid, which may become purulent. Sometimes they dry up and disappear, but they may leave an ulcerated surface which heals slowly.

Painless whitlows may develop on the fingers. The finger becomes swollen and œdematous, and suppurates. The swollen tissue necroses, and the necrotic process may involve tendon, muscle, and even bone. These sores heal slowly and may leave considerable deformity. They are very apt to recur.

Changes in the joints are often met with—in 20 to 25 per cent, according to Schlesinger. The trophic joint condition which is known as Charcot's disease is the same morbid process that is met with in tabes. It usually develops suddenly. The joint swells, and there may be considerable swelling of the limb in its neigh-

[1] Very occasionally there is anæsthesia to cold, heat being well felt. The reverse condition is sometimes met with. A few cases have been described in which the temperature sense has been alone impaired, there being no defect in the perception of pain.

bourhood. There is no pain, redness, or fever. Enlargement of all the tissues of the joint occurs, and often an extensive formation of new bone takes place in an irregular manner in this newly formed tissue. The ends of the bones in the neighbourhood of the joint may remain enlarged; commonly, however, atrophic changes take place, there is erosion of the cartilages, and wasting with, it may be, dislocation of the head of the bone.

The following table, which is taken from Schlesinger's work, illustrates the frequency with which the different joints are affected in tabes and syringomyelia:—

	Syringomyelia.		Tabes dorsalis (Büdinger).
Shoulder	52		38
Elbow	39		9
Wrist	22		?
Thumb	2	(finger joints)	8
Hip	6		59
Knee	10		110
Ankle	8		25
Jaw	4		2
Sterno-clavicular	6		?
Acromio-clavicular	1		?
Total	148	(150?)	251

It is interesting to note that whereas in tabes 80 per cent of the arthropathies occur in the lower extremities, in syringomyelia the relative frequency is almost exactly reversed.

In syringomyelia trophic *changes in the bones* sometimes occur, and spontaneous fractures, involving usually the bones of the upper limbs, are occasionally seen. The healing process in these spontaneous fractures is often very slow.

Scoliosis and kyphosis in the dorsal region of the spinal column are very frequently met with in syringomyelia, and although often of slight degree the deformity thus produced may be considerable. The spinal curvature may be in part due to weakness of the dorsal muscles, but trophic changes in the vertebræ are probably concerned in its production. Marie and Astié have drawn attention to a not uncommon deformity of the chest—the *thorax en bateau*, in which there is a sinking in of the anterior thoracic wall. Enlargement of the hands and feet similar to that seen in acromegaly is sometimes met with.

Bladder symptoms and disorder of the rectal sphincter seldom occur until the late stages, except in those rare cases in which the lumbo-sacral cord is first affected.

The sexual functions are very rarely interfered with.

In quite a number of cases there are signs of *paralysis of the cervical sympathetic* on one, often on both sides. There is a diminution in the size of the pupil on that side, with commonly some impairment of the light reflex, narrowing of the palpebral fissure, and retraction of the eyeball. The pupil fails to dilate with cocaine or when the eye is shaded. The sweat secretion is diminished on that side of the face and neck.

Bulbar symptoms are not uncommon and are often unilateral. Paralysis of one-half of the palate and tongue and of one vocal cord is a common association. Facial paralysis is sometimes seen. Alterations in articulation depending on these various paralyses may be present. Nystagmus is fairly frequent, and occasionally some of the external ocular muscles are paralysed.

Vision is not usually interfered with. The optic discs are almost always normal. The fields of vision rarely show pathological changes. In most of those cases where there has been peripheral contraction an hysterical element has been present.

The symptoms in syringomyelia vary according to the position of the lesion. Thus Schlesinger recognises *four types*: (*a*) cervical, (*b*) dorso-lumbar, (*c*) sacro-lumbar, and (*d*) bulbo-medullary.

Further, great differences occur in the clinical picture of the disease, according to the preponderance of individual symptoms; thus in one case the muscular wasting, in another sensory changes, while in another trophic alterations form the most striking feature.

Diagnosis. — There is no single symptom which is absolutely pathognomonic of syringomyelia.

The form of dissociated anæsthesia which occurs in this disease and constitutes its most constant and characteristic symptom may be met with in hysteria and occasionally in a peripheral neuritis.

A pure dissociated anæsthesia of the syringomyelic type accompanied by a slowly progressing muscular atrophy can only depend upon a progressive intra-spinal lesion, syringomyelia, or other central new formation.

If in addition there are characteristic vasomotor and trophic changes, the diagnosis of central gliosis (syringomyelia) is practically assured. Further evidence is forthcoming if the distribution of the symptoms is such as to point to the cervico-dorsal region of the cord being the seat of disease, for it must be remembered that this is the region most commonly affected. Such symptoms are wasting of the hand muscles, anæsthesia of the upper limbs and thorax, sympathetic paralysis, spinal curvature, spastic paraplegia, etc.

Great differences occur both as regards the nature and the distribution of the symptoms. In one case muscular atrophy, in another sensory changes, or again trophic lesions, painless whitlows, cutaneous bullæ, etc., may constitute the most striking feature at the time the case comes under observation.

It must not be forgotten that, although the

cervico-dorsal region of the cord is much the most common seat of the disease, cases occur in which the lower part of the cord is also, or it may be alone, affected. In such a case the sensory changes, muscular atrophy, etc., are located in the lower limbs. Cases of bulbar syringomyelia also occur. These atypical cases are probably often unrecognised. It is important to realise this, in other words, to dispel the misconception which appears to be very prevalent that syringomyelia is essentially a disease which manifests itself in the upper extremities. Bearing in mind that *the character of the symptoms is of greater diagnostic importance than their distribution*, in considering the differential diagnosis it will be convenient to refer especially to the cervico-dorsal or common type of the disease.

A number of different conditions may closely simulate syringomyelia, especially in its early stages. The classical case in which there is wasting of the hands is often diagnosed as *progressive muscular atrophy*. More than once I have seen this mistake occur. The explanation is that the latter disease is much more generally recognised, and its symptoms more widely known than those of syringomyelia. *In every supposed case of progressive muscular atrophy syringomyelia must be excluded before a positive diagnosis is arrived at.* The hands, arms, shoulders, and thorax must be most carefully examined for any trace of dissociated anæsthesia, the existence of a patch of which, often of very limited extent in early cases, will determine the diagnosis between the two diseases under consideration.

Trophic changes in the skin, whitlows, bullæ, etc., arthropathies, spinal curvature, and sympathetic paralysis will, if present, confirm the diagnosis of syringomyelia. Stigmata of degeneracy, such as defective formation of the pinna of the ear, extra digits, an abnormally high palatal arch, an asymmetrical head, etc., are signs to which one is inclined to attach some weight in diagnosis, for they occur in quite a considerable proportion of cases.

Amyotrophic lateral sclerosis is another disease for which syringomyelia may be mistaken. The points of differential importance are similar to those which we have considered under progressive muscular atrophy. In addition, spasticity of the upper limbs with increased arm-jerks, a markedly exaggerated jaw-jerk, an increase of the excitability of the muscles on mechanical stimulation, are usually present in this disease, and will serve to distinguish it from syringomyelia.

The diagnosis of syringomyelia from an *intramedullary spinal tumour* is always difficult and may be impossible, for these tumours not unfrequently arise from a pre-existing central gliosis.

Cervical pachymeningitis is commonly associated with wasting of the upper extremities and anæsthesia; it may, however, be usually distinguished by the severe shooting pains which are commonly present in the arms. Further, the anæsthesia is not of the characteristic syringomyelic type, while vasomotor and trophic changes and spinal curvature do not occur. It must be remembered that the two conditions—syringomyelia and pachymeningitis—are sometimes associated.

An *extra-medullary tumour* may also produce muscular wasting and anæsthesia, with paraplegia. If situated in the cervico-dorsal region pains in the arms are usually complained of. Severe pain in the back is a common symptom. Brown-Séquard's paralysis, if present, affords strong support to the probability of a tumour. Other symptoms of syringomyelia above referred to are commonly absent. Dissociated anæsthesia is sometimes produced by an extra-medullary tumour. In a case of extra-medullary tumour, which was under the care of Dr. Byrom Bramwell, this symptom was present. The tumour, which was of small size, pressed on the cord in the upper cervical region. The absence of pain in the back and of root pains in this case, and the presence of wasting of the upper limb, dissociated anæsthesia, etc., suggested syringomyelia, a diagnosis which was shown post-mortem to be erroneous.

The cervical region of the cord and cervical root may be pressed on in *spinal caries*, but in this case, if the symptoms have persisted for any length of time, signs of disease of the vertebræ (irregularity, rigidity, pain on movement, tenderness on pressure) usually coexist.

Brachial plexus neuritis may simulate syringomyelia, but the signs of irritation (pain, etc.), the history, and the strictly unilateral distribution of the symptoms usually permit of a diagnosis being made without difficulty.

Occasionally *disseminated sclerosis* is resembled by syringomyelia, but the absence of anæsthesia, the speech affection, giddiness, and frequency of optic atrophy in the former disease, together with the history, usually place the diagnosis beyond doubt.

Hysteria and syringomyelia have been confused, and—strange though it may seem—the possibility of such a difficulty arising is not remote when it is remembered that the two diseases are not uncommonly associated. Definite signs of organic disease, such as local muscular atrophy, etc., must be sought for in determining this question.

An *acute central myelitis* or *hæmorrhage* into the cord may produce symptoms identical with those of syringomyelia. The history of onset is in such a case the chief guide to the diagnosis. *The possibility of pre-existing syringomyelia should always suggest itself where the history appears to indicate spinal hæmorrhage.* Careful inquiry must be made as to the existence of

symptoms suggesting syringomyelia prior to the acute onset. Rapid extension of the lesion through a considerable vertical extent of the spinal cord is suggestive of hæmorrhage into a pre-existing cavity.

Morvan's Disease.—No article on syringomyelia, however brief, would be complete without a reference to the symptom-complex which is known as Morvan's disease.

Morvan, a French physician, described in 1883 a group of cases which he had met with in Brittany, the chief symptoms of which were extensive whitlows, analgesia of the upper extremities, atrophy of the arms and hands, pains in the arms, arthropathies, spontaneous fractures, etc.

At the first glance the resemblance of these symptoms to those of syringomyelia is striking. In the cases described by Morvan, however, the trophic lesion of the fingers occupied such a prominent place in the clinical picture that many authors, among them Charcot, held that Morvan's disease was a distinct condition; other observers were of opinion from the first that syringomyelia and Morvan's disease were identical, a view which received support from post-mortem evidence, for it was found that central gliosis and cavity formation were present in both groups of cases. In more than one case of Morvan's disease changes were found in the peripheral nerves, a fact which the supporters of the independent nature of the two diseases were not slow to grasp. Hoffmann, however, who paid particular attention to this question, showed that in some cases which answered to the clinical description of Morvan's disease there were no discoverable peripheral changes; while he found, on the contrary, that changes in the peripheral nerves were sometimes present in syringomyelia. According to Hoffmann, "Die maladie de Morvan unterscheidet sich also ebensowenig anatomisch von der Syringomyelie wie klinisch" (*zur Lehre von der Syringomyelie*, s. 58). *The opinion that Morvan's disease is nothing more than a type of syringomyelia is almost universally held by neurologists at the present time.*

A possible etiological relationship between syringomyelia and *leprosy* was suggested by Zambaco in 1892. This author drew attention to the circumstance that in Brittany, where Morvan's disease was first recognised, leprosy was somewhat prevalent, and pointed out that some cases which had been classed with Morvan's disease were probably examples of the former affection. When it is remembered that in leprosy, muscular atrophy, various kinds of trophic lesions, and even dissociated anæsthesia occur, the possible resemblance will be apparent.

That *the two diseases are quite distinct and depend upon a different pathology* appears to have been proved by Laehr, who has devoted much attention to the study of this question.

Laehr came to the conclusion, from the examination of a large number of cases of leprosy, that in every case of leprosy changes were present in the peripheral nerves, and that the pathological changes in the spinal cord which occur in leprosy, especially in the posterior roots and posterior columns, could only be regarded as secondary. Central gliosis and cavity formation are not found in leprosy. In a considerable proportion of cases of leprosy the bacillus of that disease is detected in the spinal canal and peripheral nerves, whereas in no case presenting the undoubted characters of syringomyelia or Morvan's disease has it been found.

Prognosis.—Syringomyelia is an incurable disease. Its course varies greatly in different cases, and is, as a rule, very chronic. Although showing a tendency to slow progression, intermissions, with temporary slight improvement, are not uncommon. Occasionally the disease appears to be arrested for long periods of time. I have seen a case, for example, where for thirteen years the patient remained *in statu quo*, when the symptoms again began to progress. Patients with syringomyelia have been known to live thirty or forty years. Déjerine has even reported the case of a man in whom muscular atrophy commenced fifty years previously. The prognosis is less favourable where the lumbo-sacral region of the cord is involved and bladder symptoms are present, for in these cases there is always a risk of cystitis and subsequent general septic infection.

Schlesinger states that in bulbar syringomyelia the prognosis is much more favourable than in other subacute or chronic bulbar lesions; he mentions the case of a man who has had widespread bulbar symptoms for twelve years and who still goes about fairly well. Often the symptoms are exaggerated after an infective process, *e.g.* influenza. Sudden apoplectiform attacks, which have been ascribed to hæmorrhages into the tumour tissue and to variations in the intraspinal pressure, may occur at any time and may prove fatal.

Cystitis, general septic infection from a whitlow or other local cause, extension of the process to the medulla, and intercurrent affections, such as phthisis, are the most common causes of death.

Treatment.—No treatment is known which influences the progress of the disease.

The patient should be advised to avoid overexertion, more especially of those muscles in which there is commencing atrophy. He should be warned to take the greatest precautions to avoid local injury, for a slight abrasion of the skin may be the starting-point of a trophic sore. If pain is a troublesome feature various analgesics may be employed. Other symptoms are to be treated as they arise by appropriate remedies. Occasionally it may be considered advisable to excise a joint: favourable results

have been obtained by this procedure. In a case under the care of Sir William Gowers I have seen Sir Victor Horsley open the spinal canal and drain the cavity. The result as regards improvement was not, however, encouraging. Schlesinger is opposed to spinal puncture on the ground that such a procedure may lead to spinal hæmorrhage.

Syringomyelocele.—A rare variety of spina bifida in which the central canal of the spinal cord is distended with fluid, and bulges outward through a defect in the spinal canal. *See* Spina Bifida (*Varieties*).

Syringotomy.—The operation of curing a fistula (*e.g.* a *fistula in ano*) by cutting it.

Syrupi.—Fluid preparations of drugs in which sugar forms a constant constituent, all of which are given in doses of 1 dr. and upward; *e.g.* the *syrupus aurantii*, *syrupus ferri phosphatis*, *syrupus ferri phosphatis cum quinina et strychnina*, etc.; *syrupus* is a solution of 5 parts of saccharum purificatum in $2\frac{1}{2}$ of water, and *syrupus glucosi* contains syrup, 2 oz., and liquid glucose, 1 oz.

Sysoma or Syssomus.—A teratological type of double monster in which the twins are united by the bodies (Gr. *σύν*, together, and *σῶμα*, a body).

Syssel. *See* Balneology (*Iceland*).

System.—A combination of things (parts, structures, facts, etc.) arranged in an orderly and determinate fashion; *e.g.* a system of instruction, a system of parts (*e.g.* the nervous system), or a system of treatment (*e.g.* the Ling system), etc. *Systematic* instruction (*i.e.* teaching by lectures, the subjects being dealt with in an orderly and predetermined way, usually according to schedule) is contrasted with *clinical* instruction in Medicine.

Systemic.—Belonging to the whole organism, or, more rarely, to any special set of organs (*e.g.* those of circulation).

Systole.—The stage of contraction of the heart or of any other hollow viscus with muscular walls. *See* Physiology, Circulation, (*Cardiac Cycle*).

Tabaci Folia.—Tobacco leaves are obtained from *Nicotiana tabacum*, and contain the alkaloid nicotine ($C_{10}H_{14}N_2$), nicotianin, salts, etc.; there seems to be no doubt that nicotine is the active and injurious agent in tobacco. Tobacco has ceased to be used in therapeutics, and the tabaci folia are no longer official. Smoking may lead to amblyopia and colour-blindness, to angina pectoris, loss of appetite, and irregular action of the heart (*tabacosis*). *See* Toxicology (*Alkaloids and Vegetable Poisons, Tobacco*). *See also* Amblyopia (*Toxic, Tobacco*); Angina Pectoris (*Etiology, Poisons, Tobacco*); Appetite (*Loss*); Colour Vision (*Acquired Colour Blindness*); Heart, Myocardium and Endocardium (*Etiology, Exciting Causes, Chemical*); Retina and Optic Nerve (*Central Retinal Affection from Toxic Influence, Tobacco*).

Tabanus. *See* Parasites (*Mastigophora, Tabanus Tropicus as a Cause of Surra*).

Tabellæ.—Tablets or troches or lozenges of chocolate; e.g. *tabellæ cum mentha* (peppermint lozenges), *tabellæ cum santonina*, etc.; the only official tabella now is the *tabella trinitrini*. *See* Nitrites (*Nitroglycerin*).

Tabes.—Literally tabes means a wasting away, consumption, or a wasting disease; but the term has now come to be applied specially to two diseases, locomotor ataxy (*tabes dorsalis*) and tubercular disease of the mesenteric glands (*tabes mesenterica*). Formerly *tabes atrophica* was a synonym of phthisis, *tabes coxaria* was hip-joint disease with suppuration, *tabes diuretica* was diabetes mellitus, and *tabes pectorea* was rickets.

Tabes Dorsalis.

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See also Diabetes Mellitus (*Nervous System*); General Paralysis (*Diagnosis*); Herpes (*Herpes Zoster, Symptomatic of Tabes Dorsalis*); Larynx, Neuroses of (*Abductor or Posticus Paralysis, Bilateral*); Nails, Affections of the (*Diseases of the Nervous System*); Purpura (*Symptomatic, Nervous*); X-Rays (*in Diseases of the Spinal Cord*).

Syn.—*Locomotor Ataxy;* Fr. *L'Ataxie locomotrice.*

Definition.—A progressive degeneration of the nervous system, affecting especially the sensory structures, and characterised by atrophy of the posterior columns of the spinal cord.

Historical Introduction.—Our knowledge of tabes is the product of the last fifty years; before that period, except for a few isolated observations by W. Horn (1827) and von Steinthal (1844), these cases were all classed as paraplegia. In 1851 Romberg described the leading symptoms of the disease—optic atrophy, small fixed pupils, lancinating pains, girdle sensation, stamping gait and swaying of the

body when the eyes were shut, which last-named symptom bears his name. The Germans naturally claim Romberg as the discoverer of the disease; the French, on the other hand, claim Duchenne as the discoverer of the disease, and have even gone so far as to name it after him: they might with greater justice claim the discovery for Cruveilhier, for he in 1845 described a case and noted the grey degeneration of the posterior columns of the spinal cord. Although it was ten years after Romberg that Duchenne gave his masterly description, to which there is not much to be added and very little to be taken away, yet it was the graphic description by this clinical genius, and especially his demonstration that the ataxy was due to a failure of the correlative antagonism of synergic groups of muscles, that the disease became universally recognised, and for a long time bore the name which Duchenne gave it of locomotor ataxy.

Sir William Gowers claims that Todd discovered the disease, not I think quite justly, although he, later than Cruveilhier, made the independent observation of sclerosis of the posterior columns.

The term tabes is more applicable to this disease than locomotor ataxy, for the latter is one symptom and may not be a prominent feature, or even present during the whole course of the disease. Since Duchenne's description of the disease, an enormous number of clinical observations by different observers have been made, showing the polymorphic character of the affection.

Etiology.—It is becoming more and more an accepted fact that, of all the causes of tabes, syphilis is by far the most important; in fact it is the opinion of many authorities that if there were no syphilis there would be no tabes; and Fournier, who first pointed out the frequency of syphilitic infection in tabetic cases, calls it a parasyphilitic affection, and Möbius metasyphilis. Another disease with which tabes is intimately associated, and so closely allied as to be thought by many authorities to be one and the same disease, affecting different parts of the nervous system, is general paralysis. The pathogenesis of the two diseases is almost identical, and I have found all grades of the disease, from tabes without mental symptoms, tabes with slight mental symptoms, and tabes with severe mental symptoms, to pronounced general paralysis. According to my observations, by far the most important if not the essential factor is syphilis. The work of Erb has probably done more than anything else to support the doctrine of Fournier. In 1897 he had collected 900 cases of tabes, of which 90 per cent had suffered from syphilis; he found in 6000 other nervous cases, on the same basis of evidence, only 20 per cent. Westphal, Charcot and Virchow were always opponents of the syphilitic doctrine, but the greatest opponent has been Leyden; various authors have given different results, and very much depends upon what each considers sufficient evidence to warrant the assumption of syphilitic antecedents. Max Norme points out that as the interest in the subject has increased, the authorities, who had previously only found a small percentage of tabetic patients suffering with syphilis, were led, as the inquiry progressed, to increase their percentages.

It is argued that in countries where syphilis is prevalent tabes may be very rare, as in Bosnia and Herzegovina. Another factor is undoubtedly necessary for the production of this disease, as well as for general paralysis, and that is nervous instability, the product of civilisation; and Kraft-Ebbing sums up the causes of general paralysis as civilisation and syphilisation.

Sex.—The facts with regard to sex, age, and incidence of the disease all support the syphilitic doctrine—males are much more frequently affected than females, tabes is uncommon in women of the better classes, and when it occurs there is usually history of syphilitic infection. The disease commences in adult life, generally in the fourth or fifth decade, and about ten to fifteen years, I have found, after the primary infection; although the interval may vary from four to twenty-five years. When it affects juveniles it is invariably in the subjects of congenital syphilis.

Heredity.—Charcot laid great stress upon the neuropathic temperament as a cause of the disease; there can be little doubt that it is the quick-brained, active, and sexually excitable individual who is more prone to the disease; but one does not find a large percentage of cases giving a hereditary neuropathic taint.

Stress.—Edinger has pointed out the importance of stress as a determining factor in the production of tabes: most of my cases certainly were engaged in occupations which involved physical stress, and several of those in which the symptoms began in the arms were individuals who used their arms in their respective occupations. Thus among my own cases of cervical tabes, in a mounted policeman it began in the arm with which he held the reins; it began in the arms in a parcel-post sorter and in two packing-case makers. Edinger has demonstrated the fact that degeneration of the posterior columns can be induced in animals by excessive stress on the limbs, especially in conjunction with an artificially produced toxæmic condition. The importance of stress as a factor has also been emphasised by Byrom Bramwell.

Exposure to Cold and Wet and Unequal Temperature.—The frequency with which, in my experience, engine-drivers, policemen, postmen, workers at forges, and others subject to such conditions are liable to the disease supports this

view, together with the fact that it has been noticed that tabes has come on after the stress and hardships of a campaign in military men. Leyden and Goldscheider lay great stress upon exposure to cold, wet, and unequal temperature, but most authorities consider it as only a contributory factor.

Sexual excesses were formerly considered to be the cause—the essential cause—of tabes, but the undoubted satyriasis which occurs in many cases is not the cause but the result of the increased irritability, prior to death, of the nervous structures of the spinal cord, subserving the function of the sexual instinct. Still, one cannot get away from the fact that people who suffer with tabes dorsalis are those especially who have lived a fast life and indulged *in Baccho et in Venere.*

Alcohol.—It is improbable that alcohol of itself without syphilis can, when taken in excess, produce tabes. It can, however, produce neuritis, consequently is a potent agent in the production of irritation and destruction of nervous tissue, and may therefore act as an important contributory factor in the production and the rapidity of progress of the disease.

Trauma.—Klemperer collected a number of cases in which there was a history of injury preceding the onset of the disease. A classical monograph by Hitzig dispossessed Klemperer's observations of much of their import; and it may be accepted that there are but few cases in which true tabes, apart from syphilitic and other factors, exists. To sum up the etiology, it is the opinion of the author that syphilis, if not the one essential factor, is proved to be by far the most important factor, but that it operates only when in conjunction with several contributory predisposing or determining factors, namely, stress (physical and mental), exposure to cold and wet, alcoholism, sexual excesses, insufficient sleep, and occasionally trauma; also the psychopathic, neuropathic, or neurotic temperament, the conditions which, without syphilis, would determine neurasthenia. The same factors are contributory to the production of general paralysis, but more frequently in the latter than in tabes there is an hereditary history of insanity.

Symptomatology.—Tabes is a polymorphic degeneration; although there are certain cardinal symptoms, one or more of which, in conjunction with some other or others, is necessary before a diagnosis can be made. Still no two cases present exactly the same clinical features, although there is, by the presence of one or more of these cardinal symptoms, a universal similarity. They are as follows:—The Argyll-Robertson pupil; absent knee-jerks; lightning pains; visceral disturbances, especially bladder troubles; disturbances of sensibility.

The most important symptom undoubtedly is the Argyll-Robertson pupil, for in no other disease except general paralysis does this sign exist, and, as pointed out by Sir William Gowers, in some cases of syphilis it may be the sole objective evidence. In fact, the existence of the phenomenon alone would justify one in saying that the patient was a candidate for either tabes or general paralysis. This is the strongest argument in favour of the unity of these two diseases and of their syphilitic origin.

Eye Symptoms.—We will consider first affections of the optic nerve. One of the earliest subjective symptoms which will bring a patient under the doctor's observation is failure of sight; thus, a large number of cases in the preataxic stage are seen by the oculist. The patient may complain of dimness of vision, "things look as if smoky," or "as if a veil were in front of the eyes"; one eye is usually affected much more than the other, and it may be that not until he has lost the sight of one eye, which may happen, apparently quite suddenly, owing to the destruction of the macular fibres, does the patient seek advice. Examination of the fundus shows the disc with a sharp-edge dead-white appearance, or greyish-white, with often the lamina cribrosa shining through, giving it a mother-of-pearl appearance, the vessels normal in size and appearance, and, in advanced cases, sinuous on account of the cupping of the disc. Sometimes there is amblyopia without ophthalmoscopic changes. The optic atrophy will cause failure in colour vision, and if tested perimetrically there may be a marked limitation of the field of vision; and colour-blindness may occur, red and green disappearing usually before blue and yellow. Patients suffering with optic atrophy frequently remain for long periods of time in the preataxic stage; in fact, may never show ataxy at all.

One of my patients was twenty years in that stage. It is usual for neurologists to give comfort to their patients by telling them that although they are blind, they will probably remain free from locomotor troubles for a long time to come.

There is another side of the picture which is seen especially by the alienist, and it is my experience that a large number of these cases become tabo-paralytics.

From the observations made on 60 cases of tabo-paralysis with 30 post-mortem examinations, including microscopical examinations, I have been struck with the large number (40 per cent) that have suffered with optic atrophy, and in many instances complete blindness.

Ocular Paralysis.—Another cause of the patients seeking advice at an eye hospital is double vision; they do not go there because of the squint, as a rule, but because the vision of two objects attracts their attention and interferes with their occupation. The ocular paralysis may be paralysis of a single muscle, that of the external rectus on one side being the most

frequent. Ptosis on one or both sides, paralysis of the internal rectus or even complete paralysis of the third nerve, but much more frequently it is a partial paralysis affecting one muscle. The early ocular paralyses are usually transient, lasting a week or two or a month or two, and then disappearing; they may, however, be permanent.

There may sometimes be opthalmoplegia externa affecting one, but more often both eyes, in which all the external muscles of the eyeball are paralysed. This is a permanent paralysis.

Pupil Phenomena.—The attention of the physician may be attracted by the small, even pin-point pupils, or by unequal pupils; or while the patient is suffering severe pains or crises, he may notice that the pupils do not dilate. By far the most important symptom, however, and one which, if present, renders a diagnosis certain, is the Argyll-Robertson pupil, *i.e.* the pupil reacts to accommodation, but not to light or painful stimulus. This phenomenon is usually present in both eyes, but it may be present in one and not in the other; the reaction to light may be sluggish as compared with accommodation, but it must be remembered that sluggish reaction to light is not necessarily a pathological condition, and unless there is a difference between it and accommodation, it may be of no import. In my cases 73·5 per cent showed Argyll-Robertson pupils on both sides; 3 per cent showed Argyll-Robertson pupils on one side; 3·7 per cent were sluggish to light; and 15 per cent were inactive to light and to accommodation.

Irregularity of the pupils is also very frequent, and, independently of *synechiæ*, the pupil may be angular, elliptical, or oval.

Sensory Symptoms.—Subjective.—The earliest and most constant symptom, and one for which the patient will often seek relief, are the lightning pains. He may consider them rheumatism or sciatica; or, even when occurring in the thorax, they may be mistaken for pleurisy or pleurodynia. They occur in paroxysms and shoot down the limbs, or may be localised in some particular part. They are deep-seated, and are described as "boring, burning, stabbing, or shooting." They generally last during the whole course of the disease, and the skin may be hyperæsthetic during the attack; and in rare cases of a severe nature, paroxysms of pain may be followed by herpetic or erythematous, even bulbous eruptions. The patient may complain of formication, pins and needles, and numbness—a feeling like putty or wool on the soles of the feet. These subjective symptoms are spoken of as paræsthesia.

Objective Symptoms.—Disturbances of cutaneous sensibility to light tactile impressions, to painful impressions, as by pricking, and to heat and cold are found. The researches of Lähr have shown that one of the earliest and most constant signs of tabes is cutaneous *trunk anæsthesia* to light tactile impressions, and this probably accounts for the frequency with which "a girdle sensation" is experienced. I found it present in forty out of forty-seven cases. The zone of anæsthesia usually affects the fourth and fifth segments, and extends as the disease progresses above and below. It is very rare that it extends to the second interspace, the reason being that the cervical plexus supplies the skin in this region, and it is seldom that the upper cervical roots are affected. The anæsthesia may extend down the ulnar side of the arm; there may be hyperæsthesia above and below the anæsthetic region; this cutaneous anæsthesia of the thorax demonstrates the segmental character of the degenerative process. The region next most liable to be affected is the part supplied by the lumbar sacral roots, so that the feet and legs, especially the peroneal side, often show, even early in the disease, disturbance of sensibility. Here it is, however, more frequently loss of, or diminished sensibility to, pain. Sensibility to heat and cold persists much longer, and it is only in very advanced cases that they are lost, and then very frequently cold produces a burning sensation. Anæsthesia and analgesia of a skin area may be preceded by hypæsthesia and hypalgesia. In testing sensibility it will often be noticed that there is great delay in the response to stimuli, and that after repeated stimulation an area which was previously anæsthetic or analgesic becomes sensifacient by a process of summation. Wrong localisation of the parts stimulated is frequently observable,

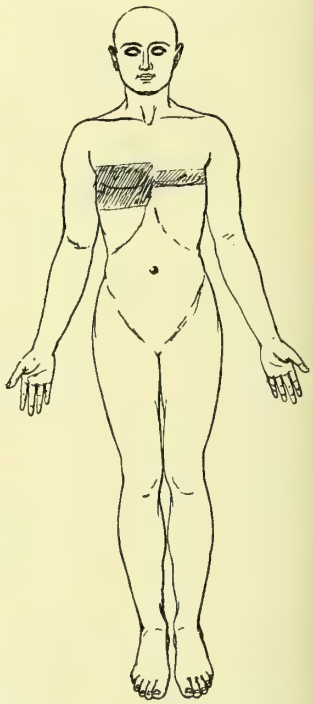


FIG. 1.—Sensory disturbances of a case of tabes in the preataxic stage. Cutaneous thoracic anæsthesia to light tactile impressions (just perceptible touching with the tip of the investigator's finger, the patient's eyes being covered). The sensory disturbance corresponds with the distribution of the fourth posterior root on the left side, and with the third, fourth, and fifth on the right. This patient presented no ataxic signs or symptoms, the knee-jerks were present on both sides. For more than a year the sole subjective symptoms were gastric crises. The diagnosis was made upon the presence of Argyll-Robertson pupils, and cutaneous thoracic anæsthesia, associated with attacks of vomiting and pain at the epigastrium. The anæsthesia extended as the disease progressed.

and occasionally there is a condition of *allochiria*, that is, referring sensation to the wrong side of the body (*see* Figs. 1, 2, 3).

Loss of cutaneous sensibility, and its extension over the surface of the trunk and limbs, progresses with the disease, but there may be pronounced ataxy without any loss of cutaneous sensibility. The bone sensibility may be lost; this can be ascertained by placing a vibrating tuning-fork on the tibia, when it will be found that the patient is unconscious of its presence. The ulnar symptom of Biernacki is another sensory test. Compressing the ulnar nerve at the elbow does not cause the well-known tingling in the fingers.

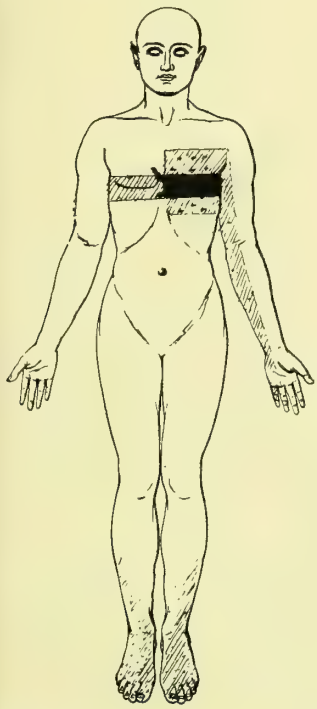


FIG. 2.—Sensory cutaneous disturbances of a case of tabes in the first stage of ataxy. The chart shows that on the left side the anæsthesia to light tactile impressions has spread down the inner side of the arm and hand (ulnar distribution) and would indicate that the posterior roots of the seventh and eighth cervical, and first to seventh dorsal were involved; whereas, on the right only the third, fourth, fifth, and sixth dorsal are affected. Owing to the overlapping of the sensory nerves to the skin corresponding to root segments, an area of cutaneous anæsthesia corresponding to two roots really means involvement of a root above and below. Above the second space the skin is supplied by the cervical plexus, consequently there is no anæsthesia. The black band indicates complete anæsthesia and analgesia. The crosses indicate some hyperæsthetic spots. There is also hypæsthesia and hypalgesia of the feet and peroneal side of legs. This indicates affection of the lumbo-sacral roots, third, fourth, and fifth lumbar, first and second sacral, and accords with the lightning pain in the legs, the bladder troubles, the absent knee-jerks, loss of joint sensation in toes, and ataxy.

Superficial Reflexes. — These may be present and active in the early stages of the disease; the plantar reflexes are absent when there is loss of sensibility in the soles of the feet; and it is common to find these absent while the epigastric are present, even exaggerated. A hyperæsthetic skin area is usually associated with increased superficial reflexes. Very frequently after an attack of pains, during which the skin is hyperæsthetic, it is subsequently left anæsthetic, the explanation being that the root fibres which convey sensations from this skin area were in a process of increased excitability prior to death, and I have several times noticed a belt of anæsthesia follow a severe attack of pain associated with gastric crises.

Joint Sensibility.—A very early symptom is the loss of sense of position of the joints, and in the great majority of my cases, where there was any recognisable ataxy in the legs, there was at the same time a loss of sense of position in the toe-joints. If the toe be bent with the patient's eyes shut, he is unconscious of its change of position; as the disease progresses and the incoördination becomes more marked, the other joints of the lower limb, —ankle, knee, and hip—are successively affected. Likewise the finger-joints, then the wrist and elbow, when the upper limb is affected.



FIG. 3.—Sensory cutaneous disturbances of a case of tabes in an advanced stage of ataxy. The patient was unable to walk without support. Deep reflexes of upper and lower limbs lost, superficial reflexes absent except over right epigastric region, where there was such hyperæsthesia and pain as to simulate pleurisy. She suffered with very severe gastric crises for some years; now that there is complete analgesia and anæsthesia over the area of the thorax indicated black, this symptom has ceased. The chart indicates complete destruction of the lumbo-sacral roots, and also of all the dorsal roots except the lower four or five, which together with the upper one or two lumbar are only partially destroyed. The light shading indicates cutaneous anæsthesia, the dots hypalgesia, which is very extensive in its distribution, affecting the upper cervical roots and a portion of the distribution of the fifth.

Sense of Position of the Limbs.—With the eyes shut, the patient is unable to place the heel of one foot on the toes of the other: his knowledge of the position of his limbs is lost through the loss of the muscular sense impressions. Likewise he is unable to touch the tip of his nose, or to make his fingers meet.

Muscular Tonus.—Owing to the loss of the sensory impressions from the limbs the reflex spinal tonus is greatly lowered, and as a result of this loss of tonus the *deep reflexes*, the knee-jerk, the Achilles tendon-jerk, and the triceps-jerk are abolished. The absence of the knee-jerks is one of the cardinal symptoms of the disease, but it must be borne in mind that in other diseases the knee-jerks may be absent, and in not every case of tabes are the knee-jerks absent. In cases of arm tabes, in cases of tabo-paralysis, and in very early cases of tabes the knee-jerks may be present on one or on both sides. To elicit the knee-jerk one knee should

be crossed over the other, or the foot may be placed on the ground with the leg at a right angle to the knee, or it may be supported on the arm of the operator in such a way that it hangs freely over. The tendon should be struck with a percussion hammer, and if the jerk be not elicited, the patient should be told to look at the ceiling and pull his clasped hands apart, when occasionally it will be found to be present, when previously not obtained. A condition of hypotonus is generally present, and proportional to the degree of ataxy. If the patient be made to lie on his back on a couch, the hypotonus of the ham-string muscles can be demonstrated in the following manner: the patient, lying flat on his back, is told to keep one leg extended on the couch, and the other is raised by the operator with the knee extended. It will be found that the leg, which in a normal individual cannot be raised to an angle of more than 120° with the trunk, can, owing to the laxity of the ham-string muscles, be raised to a right angle, and in advanced cases even to an angle of 60° with the body.



FIG. 4.—Muscular tonus.

Although there is this loss of tonus of the muscles and in advanced cases marked wasting, it will be found that all the muscles respond normally to faradism and galvanism; yet the patient in the third stage is in a paralytic condition. He is paralysed because the sensory paths, essential for coördinate movement, are destroyed.

Disturbances of Gait and Station.—A patient may first notice that he has difficulty in walking in the dark, in going up and down stairs, or that on washing his face he has felt as if he would fall, or quite suddenly he has had a "giving way" of the legs; such conditions mark the first stage experienced by the patient of ataxy. He may be tested in the following way, for when he walks into the room in the daylight he may not show the characteristic disturbance of station and gait. *Romberg symptom* is the inability to stand without swaying when the eyes are shut; this is generally present. If it is not obvious it will perhaps be found that he cannot stand on one leg, and especially if he shuts his eyes. If he is made to raise himself on his toes with the feet close together and returning on his heels he will probably have a difficulty to retain his equilibrium. If asked to walk a chalk line he may thus show the disturbance, or if suddenly asked while walking to turn round he tends to lose his eqilibrium. When observing the gait it may be noticed that he walks with rather a wider base than normal; as the disease becomes more pronounced the ataxic gait becomes more evident. He looks at his feet where he should place them; the gait is stamping, the heels being brought down first, the toes being pointed outwards and the knees extended. He throws out the advancing leg and does not bring into play the synergic muscles associated with flexion of the hip, namely the flexors of the knee and the dorsal flexors of the foot. As the disease becomes more advanced the incoördination becomes more manifest, and the patient constantly requires a stick or some one to assist him in walking. The gait is quite characteristic even to the layman. The shoulders are bent forward, the eyes looking to the feet, the knees hyper-extended, the legs being thrown out in a sudden, jerky manner, and the foot stamped heavily, heels first, on the ground. The steps are unequal, and he would fall if he were not supported, or if his attention were taken off the feet.

In the third stage of ataxy the patient is unable to stand. The anæsthesia may be so pronounced that lying in bed he is unconscious of the existence of his legs. Usually in this stage there is a great deal of muscular wasting and some deformity, such as talipes varus, equino varus, or equinus.

It is very rare that the *muscular atrophy* is due to degeneration of the motor nerves. In some few cases ataxy begins in the arm before the legs. It affects the finer movements first, such as writing, or sewing, or using tools in a manual occupation. The delicate movements concerned in opposition of the thumb and fingers are lost, and in writing (owing partly to the skin anæsthesia, partly to the loss of joint-sensibility and muscular sense) the patient is obliged to grasp the pen between the middle and ring fingers of the clenched fist, and the pen every now and then is jerked away from the paper by an over-action of the extensors of the wrist.

Athetoid and spontaneous movements may occur in advanced cases.

Visceral Disturbances.—Bladder troubles are among the most constant of the early symptoms, and may be the cause of the patient seeking advice. Sometimes it is for retention, sometimes for incontinence. He may complain of a difficulty in starting the stream due to a weakness of the detrusor, or a difficulty in holding his water, a slight cough or exertion (owing to the loss of reflex tonus in the sphincter) allowing the urine to escape into the urethra, thus exciting the reflex process of micturition and the urgent desire to pass water.

In the later stages he may suffer from residual urine, necessitating the use of the catheter, and often this is attended by cystitis. From 70 to 80 per cent suffer from bladder troubles.

Bladder crises and *urethra crises* have been described, but they are rare. The patients have an urgent desire to micturate, but are unable. They experience the most severe burning and cutting pains in the urethra, and these may be associated with lancinating pains throughout the lower extremities.

Renal crises simulating renal colic from the passage of a calculus have also been described.

Gastric crises are one of the earliest symptoms of the disease, and the attacks of pain and vomiting may be the sole cause for which the patient seeks relief. In one of my cases the patient was admitted for intestinal obstruction, and the surgeon was sent for with a view to operation. It was noticed, however, that the pupils did not dilate while the patient was experiencing severe pain, and further observation showed that it was a case of tabes. In twenty-two patients suffering with tabes, out of sixty-five that I have recently seen, gastric crises were a symptom. All such cases I have found associated with complete or partial anæsthesia in the mid-dorsal region of the trunk, often with persistent girdle sensation. The attacks of vomiting may be preceded by pain or a feeling of weight at the epigastrium, sometimes occipital headache and a feeling of distension of the stomach, and lightning pains throughout the whole body. The patients usually complain of a deep internal burning sensation. Severe attacks may last several days. The contents of the stomach, if any, are vomited, but the retching of mucous continues just as in sea-sickness, often mixed with bile, and sometimes blood or altered blood. The pain may be agonising, and, although the symptoms are most distressing during the attack, it is astonishing how soon the patient recovers when it is over.

Occasionally the patients may suffer with incomplete gastric crises, in which only paroxysms of cramp-like pain of the stomach or eructations and vomiting without pain occur.

Gastric crises may be accompanied by frequent purgations.

Intestinal Crises.—Frequent watery evacuations of the bowels may take place for days, weeks, or months, and then cease as suddenly as they appeared. These are rare.

Rectal crises are relatively frequent, and often a very early symptom. The patients complain of tenesmus and urgent desire to go to stool, of severe pain in the back passage compared to a hot iron being thrust up. During the straining it is said that evacuations of blood and slime have been passed. Much more frequently the patients suffer with constipation and difficulty in relieving the bowels without purgatives. Often they are unable to keep themselves clean, especially when they have to start micturition by a strong voluntary effort, for fæces are then apt to escape owing to loss of reflex tonic contraction of the sphincter ani. Moreover, they cannot always tell when defæcation is complete.

Genital Organs.—A very early symptom is increased sexual appetite—satyriasis. This is frequently followed by impotence and atrophy of the testicles. I have noticed that impotence is often associated with loss of sensibility in the genital organs. Absence of pain on compression of the testicles is a noteworthy symptom of the disease. There may be paroxysmal attacks of priapism in the male, and cases have been described of clitoris crises in the female. Sometimes there is hyperæsthesia and sometimes anæsthesia of the vulva.

Affection of Cranial Nerves.—In rare cases the *olfactory nerve* may be affected. The patient complains of loss of smell and of the taste of flavours. Very often they experience a foul smell like a drain or phosphorus coming on in paroxysms.

Sometimes, owing to the affection of the nasal branch of *the fifth nerve*, there is loss of sensibility of the mucous membrane of the nose.

Other affections of the fifth nerve are pains, anæsthesia, and paræsthesia in various regions of its distribution. Besides disturbances of sensibility, there may be trophic disturbances, such as rapid falling out of the teeth and absorption of the alveolus of the jaw. In such cases there may be little or no anæsthesia or pain, this agreeing with the painless character of other bone and joint affections. A curious affection of the face, known as Hutchinson's mask, in which the patient feels as if the face were covered with a cobweb, is probably due to an affection of this nerve. Other rare conditions are ophthalmia neuroparalytica, corneal ulcer, tabic ulcer of the mouth, and sialorrhœa attributed to affection of the fifth nerve.

Very rarely affection of the *glosso-pharyngeal nerve* may occur, causing loss of taste.

Eighth nerve, auditory. Irritative lesions of this nerve may give rise to paroxysmal attacks of noises in the ear like rushing water, bells, or steam whistles; or symptoms resembling Menière's disease, viz. paroxysmal attacks of giddiness; and later deafness may ensue.

Affections of the Vago-Accessorius.—Laryngeal crises are a pretty frequent early symptom in tabes. Paroxysmal attacks of dyspnœa and spasm of the glottis may occur. The symptoms may in some respects simulate an attack of whooping-cough or of laryngismus stridulus, accompanied by a burning pain in the larynx and a feeling of suffocation. The attacks may be very alarming, and come on as the result of breathing cold air or the passage of a sound. They may be accompanied by epileptiform

seizures and loss of consciousness. In most of these cases of adductor spasm there is permanent weakness of the abductors, which, when considerable, constitutes a very grave complication. In rare cases the spasm may extend to the pharynx, making swallowing impossible.

Bronchial crises have also been described, likewise *cardiac crises*, with irregularity of the heart's action, precordial pain and constriction, a feeling of suffocation, and symptoms resembling angina; or there may be tachycardia.

The hypoglossal nerve may be affected, causing hemiatrophy or atrophy of the muscles of the tongue.

Mental Symptoms.—A patient suffering with tabes may be the subject of potential insanity; consequently the disease may, owing to physical pain and suffering, and mental worry from physical disablement, excite in him an attack of mania or melancholia, with suicidal tendencies; or he may become the subject of paranoia, with delusions of persecution.

Such insane patients are subjects of pseudo-hallucinations and delusions, and put an insane interpretation upon the symptoms of the disease, ascribing the lightning pains in the limbs to enemies and unseen agencies having turned on electricity. The gastric and visceral crises they ascribe to poison put in their food, and unseen agencies twisting their bowels and scraping their stomach. Frequently, when suffering with impotence, they have the delusion that their semen is drawn off by imaginary persons at night.

I have met with a number of cases of blind tabetics who have had visual hallucinations, usually relating to burglars, policemen, and people who are coming to do them injury. Even more common is it to have auditory hallucinations, and they hear the voices of their persecutors, who they believe are the cause of all their troubles. Some of these patients afterwards develop dementia, and die of the tabetic form of general paralysis.

The first symptom of tabes may be an epileptiform or apoplectiform seizure, followed by a transitory aphasia. The patient then may develop the characteristic signs of the disease, and for years present no further mental symptoms; or, simultaneously with the cord symptoms, mental symptoms in the form of mania or melancholia, and progressive dementia may develop, associated with grandiose delusions or delusions of persecution. The case is then recognised as one of tabo-paralysis. The cord symptoms may last years, and then the symptoms of general paralysis may develop, and very frequently, as the mental symptoms become prominent, the cord symptoms become less evident; the ataxic gait, unless advanced, gives place to a shambling, shuffling gait, and not unfrequently in these tabo-paralytics the knee-jerk may be present on one side, absent on another, and I have seen it present on both sides when there has been well-marked characteristic posterior-column sclerosis associated with lateral sclerosis. The existence of the knee-jerk on one side and absence on the other in a case of tabes is of evil omen, as it means, as a rule, cerebral destruction or degeneration. In my experience about 10 per cent of the tabetic patients become tabo-paralytics, and in asylums about 10 per cent of the general paralytics are tabetic. Occasionally hemiplegia or paralysis may arise in a subject of tabes, caused by syphilitic arteritis, but this condition is rare. Tabetics are liable also to valvular disease of the heart, and of the large vessels from atheroma and arteriosclerosis (*see also* "General Paralysis," vol. iii.).

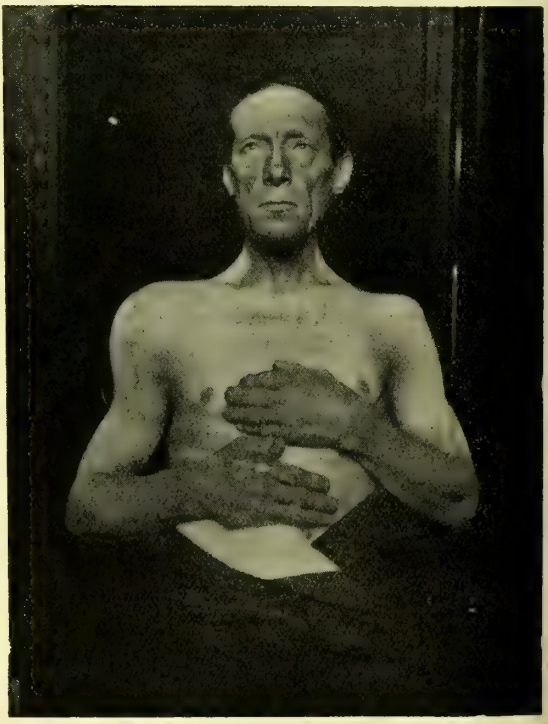


Fig. 5.—Tabo-arthropathies.

Tabo-Arthropathies.—Although there may be signs of the disease, such as Argyll-Robertson pupils and absent knee-jerks, of which the patient is unconscious, the first symptom which attracts the patient's attention may be a sudden painless swelling of a joint, possibly with dislocation or subluxation; it may have followed a trifling injury, or come on spontaneously; or the patient may suddenly, from quite an insufficient cause, sustain a fracture of one of the bones—viz. the thigh. Another form of the disease is the tabic foot: the bones of the tarsus are deformed; the foot is shortened and thicker in the instep, and the sole flattened, and there is grating on movement. As a rule, all these joints affections, as well as the fractures, are

painless and unattended by fever. They are sometimes, however, painful.

The joints most affected are the knees, hips, ankles, and shoulders, but almost any joint, even the vertebral, may be the seat of the disease.

The fluid poured out into the joints which causes the swelling is serous, and very rarely undergoes suppuration, and may be so abundant as to rupture the capsular ligament, and escape into the tissues around. The articular surfaces become eroded, and even the heads of the bones may be absorbed, producing deformities and shortening. Associated with the process of atrophy there may be development of osteophytes, and it may be difficult sometimes to distinguish the disease from rheumatoid arthritis, with which it is closely allied. This joint is often called "the Charcot-joint" because of the masterly description he gave of this tabic affection.

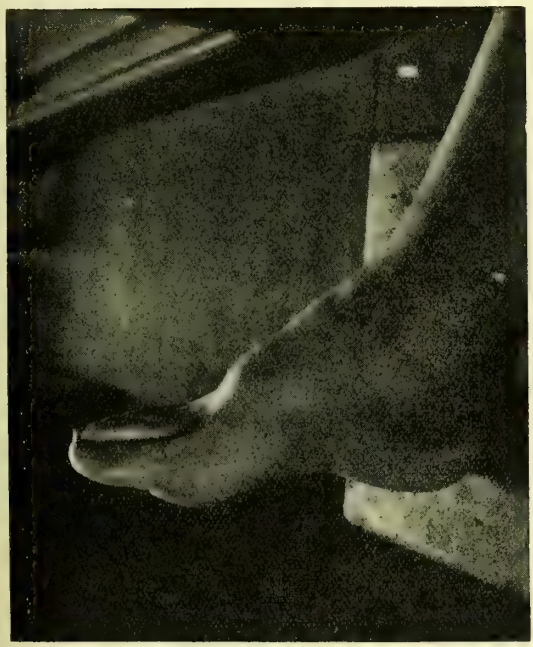


FIG. 6.—Tabo-arthropathies.

Although spontaneous fracture occurs so readily, callus is thrown out often in abundance, uniting the ends. Sometimes tabo-arthropathy may be the sole prominent feature of the disease. I have one patient who has been so affected twenty-two years, and it is my experience that it is frequently accompanied with gastric crises, and is more common in women than in men.

Perforating Ulcer of the Foot.—This is a fairly common affection, and usually starts in a corn on the sole of the foot which undergoes suppuration, forming a hole as if a nail had been driven in. The ulcer is painless, but will not heal, and from it is discharged a thin, foul-smelling, purulent fluid. At the bottom of the hole there is often carious bone, and sometimes the ulcer perforates through the foot.

MORBID ANATOMY AND PATHOLOGY.—From the multiple character of the symptoms of this disease, it is obvious that multiple lesions of the nervous system may occur; and although the posterior columns of the spinal cord and the posterior roots are invariably affected to some extent in all cases, yet the morbid changes may



FIG. 7.—Perforating ulcer of foot.

by no means be limited to these structures. The peripheral nerves, both motor and sensory, may present degenerative changes; any of the cranial nerves may be affected, especially the optic, by a degenerative atrophy, and, in a certain number of cases, the cerebral cortex. The disease is therefore a polymorphic morbid process affecting almost any part of the nervous system, although certain structures are affected earlier and more often than others. It is therefore manifest that to speak of the disease as sclerosis of the posterior columns or leuco-myelitis posterior is incorrect.

The Naked-eye Characters of the Morbid Process.—On opening the spinal canal in a case of advanced tabes the most obvious change observable is the flattening of the posterior surface, and the thinning of the posterior roots, especially those forming the cauda equina. These roots, which are normally much larger than the anterior roots, are now smaller, being sometimes reduced to one-third of the natural size, and presenting a grey instead of a white appearance, contrasting therefore both in colour and size with the healthy anterior roots. Experiments have shown that the intra-medullary projections of posterior roots form the great bulk of the fibres of the posterior columns, and this accounts for the flattening of the posterior surface of the cord; for the projections of these posterior roots in the spinal cord have atrophied like the roots. Very frequently the membranes are thickened over the posterior surface of the cord, where the atrophy has taken place, but by no means invariably, nor to an equal degree. This is important to bear in mind, because it has been considered by some authorities that

the meningeal thickening is due to an irritative process, and causes the degeneration met with in the spinal cord. On taking out the spinal cord and making a transection, the posterior column is obviously smaller than natural, and presents a grey appearance, thus contrasting with the remaining white lateral columns.

Microscopical Examination.—(*a*) Of the roots. Section of the roots of the cauda equina, stained by Weigert or Pal method, shows a more or less complete atrophy of the fibres of the posterior roots, the anterior roots appearing normal. Instead of the blue rings of myelin sheaths, are seen connective tissue and vessels. Teazed preparations of the roots, after staining with osmic acid, do not exhibit the appearances of Wallerian degeneration; the myelin sheath is either entirely absent or very much attenuated, as if the process were one of slow regressive atrophy rather than acute degeneration. Empty neurilemmal sheaths, with proliferated nuclei, fibrous tissue and vessels, showing chronic inflammatory changes, are apparent. Comparative examination of the coats of the vessels of the anterior and posterior roots shows no essential difference; moreover, the vascular changes are not constant, and are quite insufficient therefore to explain the degenerative change. In cases of prolonged tabes occurring in people past fifty, vascular changes of the nature of arteriosclerosis or arterio-capillary fibrosis are not unfrequently met with, but this cannot explain the election of the posterior roots by the morbid process. Such degeneration of the posterior roots extends back as far as the ganglia, whence they originate.

Section of the ganglia examined by the same Weigert method shows a marked contrast in the appearance presented by the proximal and distal ends. Whereas, at the proximal end, the fibres emerging from the ganglion forming the posterior root may be in great measure, or even completely, atrophied, those at the distal end, which are proceeding to form the sensory fibres of the cerebro-spinal nerves, are practically healthy and unaffected. Examination of the ganglion cells by Nissl and other methods may reveal chromolytic and other changes, even atrophy; but, as a rule, the cells of the ganglion present a fairly normal appearance, and although some authorities have concluded from their observations that the changes met with in the ganglion cells are sufficient to account for the degeneration of the posterior roots, yet most authorities are of opinion that they are inadequate and inconstant. The farther the peripheral nerves are examined from the ganglia the more likely are changes to be found; consequently, in advanced cases of tabes, atrophy of the small nerve fasciculi in the skin may be observed, also the nerves of other structures, such as muscle (which contains a large number of sensory fibres); but these peripheral nerve changes only occur, as a rule, in advanced cases, and are quite insufficient to account for the symptoms. The spinal element of the disease is essentially due primarily to an affection of the intra-medullary projections of the posterior roots, afterwards extending back as far as the ganglion of origin. *Vide* diagram, Fig. 8.

The segmental character of the anæsthesia occurring in tabes supports the view of Leyden, that is *a segmental spinal affection*. But ataxy may occur without any anæsthesia, showing that the fibres conducting cutaneous sensations in the cord have not been affected; but the fibres conducting muscular sense, joint and tendon impressions have been affected, so as to produce the ataxy. Pierret and Charcot long ago showed that a certain portion of the

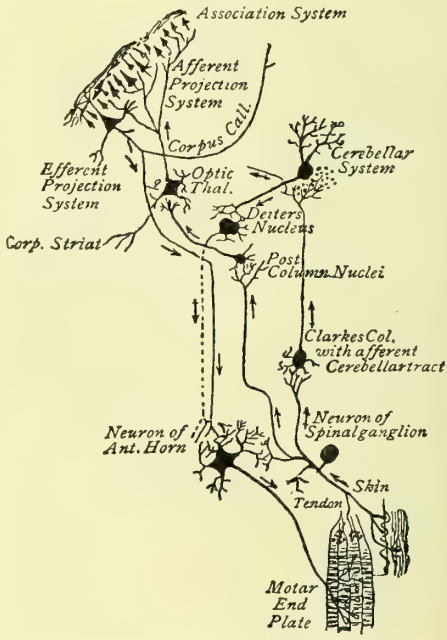


FIG. 8.—"Sensibility."

postero-external column, which they called the "bandelette," is the earliest affected in tabes; and, as we shall show, the fibres in this region convey sensory impressions to the anterior horn cells and to the cerebellum by way of Clarke's column. The former are concerned with the reflex spinal tonus, the latter with afferent impressions enabling us to maintain our equilibrium; so that destruction of these fibres alone would account for ataxy and loss of deep reflexes apart from cutaneous disturbances.

A posterior root on entering the spinal cord terminates in three sets of fibres—a set of short fibres which end almost immediately in the spinal segment to which the root belongs. This set of fine fibres forms Lissauer's tract, and ends in the substantia gelatinosa of the posterior horn. These fibres are probably concerned with cutaneous sensibility, and may be partially or

completely atrophied, according to the stage of the disease and the degree of disturbance of cutaneous sensibility.

Next, there is a set of coarse fibres of medium length which enter on the inner side of the posterior horn, in what is called the "cornu radicular zone." These pass forwards and upwards, being pushed forward by the fibres of the next entering root, and they come to occupy the anterior and middle portion of the postero-external column, sending fibres which break up into collaterals in the grey matter (*a*) around the cells of the anterior horn, (*b*) around the cells of Clarke's column.

There is yet a third set of long fibres which pass forwards and towards the mid-line to enter the posterior median column. In the case of the lower extremities these fibres form the column of Goll, which runs up the whole length of the spinal cord to end in the cells of the funiculus gracilis.

These three sets of fibres forming the greater part of the posterior columns may be looked upon respectively as the first afferent channels for spinal, cerebellar, and cerebral impulses. Each root contains fibres conveying impressions to each of these termini, and the three together are essential for perfect motor action, and co-ordination. Their disease interferes with the guiding impressions coming from the joints, tendons, muscles, and skin essential for perfect locomotion and motor activity; but in the posterior columns of the spinal cord there are other sets of fibres which have their cells of origin within the grey matter; these are endogenous association fibres serving to link up the spinal segments of different regions of the cord. They are affected, but at a much later date than the exogenous fibres, and no doubt it is their affection which leads to severe ataxy and eventually to the complete helplessness of the paralytic stage of tabes.

These endogenous fibres are ascending and descending and occupy four regions of the cord: (1) the comma tract; (2) a triangle to the inner side of the posterior horn; (3) a region corresponding to the anterior portion of the posterior column, called the cornu-commissural zone. In the lumbar region (4) a small oval area is found occupying the middle line of the posterior column, the fibres of which pass backwards in the sacral region to form a small triangle.

The whole of the exogenous fibres may be destroyed, also nearly the whole of the endogenous, but it is rarely that some of the endogenous fibres cannot be found in the cornu-commissural zone.

Occasionally atrophy of the cells of Clarke's column occurs with degenerative atrophy of the cerebellar tracts. Occasionally the anterior horn cells show atrophic changes, especially certain groups supplying the small muscles of the hand or the muscles of the feet and legs; as a rule, however, the anterior horn cells fibres and roots are normal.

In some cases, especially where there have been changes of the cerebral cortex, degeneration in the pyramidal tracts may be found. This is the rule rather than the exception in tabo-paralysis.

In arm-tabes the posterior roots which enter into the formation of the brachial plexus are affected, and in rare instances the lumbo-sacral roots are not affected. The same three sets of fibres in the spinal cord undergo degeneration and atrophy, but a section of the cord in the cervical region would, in such case, show no degeneration in Goll's column. The long set of fibres conveying impulses which will eventually reach the cerebral cortex, occupies a position in front of and overlapping the triangle of fibres forming Goll's column. These proceed to Burdach's nucleus in the medulla.

Atrophy and sclerosis of any of the cranial nerves may occur, accounting for the symptoms observed during life, but the most frequent and the most important is the grey atrophy of the optic nerve, which is associated with no apparent change in the vessels. It is a progressive atrophy of the fibres back to the ganglia cells of the retina, which in prolonged cases may even themselves undergo atrophy.

The Argyll-Robertson pupil, which, as we have seen, is the most important sign of the disease, has so far not been satisfactorily explained. It is said that there is an atrophy of fibres of the corpora quadrigemina, and that thereby impulses produced by light stimuli traversing the optic nerve, are interrupted in their passage to the motor nucleus of the sphincter iridis. This, however, in the writer's opinion, is not sufficiently demonstrated to be acceptable.

Cerebral Cortex.—Atrophy of the tangential and supra-radial fibres of the cerebral cortex has been described by many authorities. Undoubtedly some of the cases may have been incipient tabo-paralysis; others may have been true tabes or tabes with mental symptoms; it is quite possible that in prolonged cases of tabes an associated atrophy of such structures physiologically correlated may occur.

Diagnosis.—A patient suffering with tabes will in all probability seek advice, not for the characteristic signs which differentiate the disease from all other diseases, but on account of some subjective symptom which causes him pain, discomfort, or interferes with his occupation or business. A mistaken diagnosis in general arises, not from the practitioner not knowing, but from his not looking for the characteristic signs, namely, the Argyll-Robertson pupils, absent knee-jerks, sensory disturbances of the skin, and Romberg's sign. In this way the lightning pains may be mistaken for neur-

algia, the gastric crises for functional disturbance or organic disease in the stomach; the true nature of spontaneous dislocations and fractures may be overlooked; bladder troubles may be attributed to organic disease, with which, of course, sometimes the tabic condition is associated. The doctor, when called to a case of tabes suffering with severe pains, will notice that the pupils are not dilated; and I have already alluded to a case of gastric crises with distended bladder and suppression of urine admitted to the hospital, and the surgeon sent for with a view to operation. It was noticed in the paroxysms of pain that the pupils still remained contracted; other signs of tabes were then found, and the patient recovered without any surgical interference. Another case came under my observation in which abdominal section had actually been performed. In the case of visceral crises, the differential diagnosis can be made by attending to the mode of onset, the duration and mode of subsidence of the attack, the normal condition of the affected organ between the paroxysms, and the presence of other symptoms and signs which are characteristic of the disease. It must be remembered that all these conditions for which a patient may seek advice can and do occur in the preataxic stage, and that the knee-jerks are not necessarily absent, although usually so.

Another very early symptom, as already pointed out in the symptomatology, is a transitory ocular paralysis; this, in conjunction with Argyll-Robertson pupils and one of the other signs or symptoms, is sufficient to warrant a diagnosis of tabes. Again, the first symptom of tabes may be defective vision, and ophthalmoscopic examination may discover commencing optic atrophy; if this is combined with one or more symptoms or signs, tabes may be diagnosed; and even with only primary optic atrophy, and no other symptom or sign, tabes or the closely allied, if not identical morbid process, general paralysis, may be anticipated.

Certain cases of multiple neuritis which are termed the pseudo-tabic form, arising from alcoholic, arsenical, diphtheritic, and even typhoid poisons, may be mistaken for true tabes. Some of these cases of pseudo-tabic neuritis have been reported as locomotor ataxy which have got well; in none of these, however, was the Argyll-Robertson pupil present, and a careful investigation of the signs and symptoms will show that they do not correspond entirely with those of tabes.

The ataxy occasioned by a cerebellar tumour might be mistaken for tabes; there is, however, in such a disease occipital headache, optic neuritis, absence of lightning pains, and usually the presence of knee-jerks. There may be post-neuritic atrophy in cerebellar tumour, but the small size of the vessels will distinguish it from the primary optic atrophy of tabes.

Hysterical ataxy can be differentiated by attention to the fundamental signs and symptoms of tabes.

Hereditary ataxy (Friedreich's disease) affects several members of a family; the characteristic pupil phenomena of tabes are absent, and although there may be marked ataxy, there is no disturbance of cutaneous sensibility.

Syringomyelia may in some cases present symptoms like those of tabes, but there is usually wanting the characteristic signs of the pupils, the lightning pains, the absent knee-jerks; moreover, the sensory disturbances are unlike those of tabes, touch being appreciated, but pain and heat and cold not, and there are frequently degenerative muscular atrophies.

The disease which is most likely to be mistaken for tabes is the tabetic form of general paralysis; in fact, a number of cases of tabes become general paralytics, and a certain number of general paralytics may develop tabic symptoms: in the writer's opinion, the two diseases are one and the same morbid process affecting different parts of the nervous system.

The question as to whether mental symptoms are present in a case of tabes is one of great importance in diagnosis, because of the serious consequences that may arise, and the necessary steps to be taken in the interests of wife, friends, and relations to prevent social difficulties arising. A tabetic patient may become irritable and addicted to alcoholism on account of his infirmity, and the symptoms may suggest the onset of the more serious brain disease. A family history of insanity will make that more probable; but even then, not necessarily does it warrant a diagnosis of general paralysis, although such a condition must be anticipated and the friends warned of the danger. Again, in locomotor ataxy excessive sexual passion may arise in the early stage of the disease, and involve social difficulties and even criminal charges.

A man suffering with ataxy, especially with a psychopathic history, may develop mania, melancholia, or paranoia, and usually puts an insane interpretation upon the symptoms from which he suffers. It does not necessarily follow, therefore, that he is a general paralytic. The feature of this disease—general paralysis—is not necessarily grandiose delusions, although such is very frequently the case; there may be extreme mental depression with delusions of persecution. The speech is not necessarily affected, nor the handwriting in the earliest stages of the disease, although sooner or later it will be. The one characteristic symptom is *progressive dementia* with some change of character.

Prognosis and Course.—Tabes rarely ends fatally in a few years, unless as a result of some intercurrent disease or the onset of general paralysis. Patients may live thirty years or

more after the first onset of symptoms; ten to fifteen years is probably a fair average after the symptoms have become pronounced. If a patient suffers with continuous bladder trouble and cystitis through neglect of catheterisation when there is residual urine, he is apt to develop pyelo-nephritis, which may terminate fatally. Again, cystitis too often arises from the use of a dirty catheter: too much care, therefore, cannot be exercised in attending to this detail—so important in the treatment. One feature in tabetic cases is the marasmus, partly due to the influence of the withdrawal of sensory stimuli or muscular metabolism, partly to the pains, gastric crises, and often to the drugs, such as morphia, etc., taken to relieve them, which interfere with assimilation and nutrition.

In the third paraplegic stage, when the patient is bedridden, or when he is obliged, from diseased joints, to take to his bed, bedsores are liable to supervene and give rise to septic infection. Such patients in their weak exhausted state are more liable also to a low form of pneumonia or broncho-pneumonia, which may end fatally. Occasionally a patient may die from laryngeal spasms with epileptiform convulsions. Death may arise from aneurysm, valvular disease of the heart, chronic Bright's disease, or bronchitis and emphysema with which the tabetic condition may be associated. For the conditions which give rise to tabes also tend to chronic arterial degenerative changes.

The PROGNOSIS is *unfavourable* in all cases, for the disease in most instances is progressive: it cannot be cured, it can seldom be arrested. The cases of supposed cure and very often of supposed arrest of the disease are merely an alteration of the subjective attitude of the patient towards the symptoms from which he suffers, under the influence of suggestion of a new doctor with a new specific. Cases, however, do occur in which the disease remains *in statu quo* for a great number of years, or even shows symptoms of improvement: opthalmoplegia passes off, bladder troubles cease, laryngeal crises no longer occur, and the writer has met with cases in which pains or gastric crises have been very severe for numbers of years and then become less and less marked. As a rule, however, the pains last during the whole course of the disease: it is remarkable that a large number of cases commencing with optic atrophy remain, as Benedikt, Gowers, Marie, and Déjerine have pointed out, in the preataxic stage. The writer has already alluded to his experience in this, but he has also pointed out how frequently such cases of optic atrophy become tabo-paralytics. It is a fact that with the onset of dementia in tabo-paralysis, the ataxic symptoms and lightning pains markedly diminish and even altogether cease, as if the affection of the brain was associated with an arrest of the spinal disease.

TREATMENT.—No drugs can replace the degenerated nervous tissue, nor prevent the premature decay with which certain structures of the nervous system are affected. When once the disease has manifested itself, the first indication is to adopt such measures as will lead to arrest of the rapid development of the morbid process upon which the symptoms of the disease depend. We have already emphasised the importance of stress as a contributory factor in the production of the disease, therefore all occupations involving muscular fatigue should be avoided if possible. Prolonged standing, exposure to wet, cold, and changes of temperature are all liable to injurious consequences; and worry, excitement, and the stress and mental anxiety associated with business responsibilities, are liable to lead to aggravation of the disease; but of all the causes against which the patient should be warned, excesses *in Baccho et Venere* are the most important. In fact, all conditions which would tend to neurasthenia are to be avoided.

We have already seen that the toxine of syphilis is acknowledged (by most authorities) to be the most important, if not the essential cause of this disease; one would expect mercury inunction or a course of iodide of potassium, as in syphilitic diseases, to produce beneficial results. As a matter of fact, it is seldom that this course of treatment does any good; sometimes it does harm, lowering the patient's strength and aggravating the disease. Still, there are some cases in which a course of inunction judiciously applied, or iodide of potassium in 10 or 15 grain doses, combined with a drachm of Liquor Hyd. Perchlor., is advisable. These are early cases of optic atrophy or ocular paralysis, or cases in which the symptoms have come on within five or six years of syphilitic infection, especially if the patient has not before been treated by a course of mercury. The writer has seen a few cases improve upon this treatment.

The remedies that are usually employed with some measure of success are arsenic and strychnia, either separately or in combination. Nitrate of silver in olden times was a favourite remedy in the form of a pill; it had the disadvantage of producing argyria and consequently has fallen out of use. The coal-tar preparations, antifebrine, antipyrine, phenacetin, exalgin, are in many cases very successful for alleviating the pains. The writer has found antipyrine the most successful in 10 to 15 grain doses, repeated every hour or two for three doses. Methylene blue in 1 grain doses; chloride of aluminium in 2 to 4 grain doses; and salicylate of soda in 15 to 30 grain doses in combination with Tincture Cannabis Indica have been found useful: this latter drug may also be combined

with any of the coal-tar preparations. It is well not to employ morphia if it can be avoided, and never to put into the hands of a patient the hypodermic syringe, or a worse condition even than the disease may be produced.

In gastric crises the before-mentioned drugs may be tried, but, as a rule, morphia is the only remedy which is efficient in severe cases, although oxalate of cerium in 2 to 5 grain doses may be tried.

Electrical Treatment. — *Galvanism* has been recommended, one electrode being applied to the neck, the other to the lumbar region of the spine, a current not exceeding 5 to 8 milliampères being used, or the current may be applied by moving an electrode down the spine (labile), or made to pass right down the spine, both electrodes being fixed (stabile).

Erb's Method.—The kathode, of medium size, is fixed over the superior cervical sympathetic ganglion, then the larger anode is moved down the opposite side of the vertebral column close to the spinous processes in the lower cervical and upper dorsal regions. By either method the sitting should not be more than five minutes.

Faradism.—A large electrode is placed on the thorax or neck, whilst the brush is stroked over the skin of the buttocks and lower extremities or over the anæsthetic areas. The strength should be enough to be just painfully appreciated by the patient, but not to cause muscular contractions. The sitting should not occupy more than ten minutes.

Some authorities recommend the actual cautery over the spine, especially when there is pain in this region.

Aconitia ointment and hypodermic injections of cocaine $\frac{1}{4}$ to $\frac{1}{6}$ grain or menthol liniment may be employed to relieve the pains of hyperæsthetic cutaneous areas.

Hydrotherapy. — Cold douches and simple warm baths, natural thermal springs, and springs containing carbonic acid are used in Germany, but have not found much favour in England. The baths of Mannheim and Wildbad are recommended. The hot mineral water baths of Bath, and hot brine baths of Nantwich and Droitwich might be recommended.

Mechanical Treatment.—About twenty years ago nerve-stretching was introduced; benefits and even cures were said to result. This treatment, as well as suspension and bloodless nerve-stretching have by experience been found to be useless. The latter, carelessly applied, has led to fracture. These methods, when they have done good, have probably merely affected the subjective attitude of the patient towards his disease, and have not had any real effect upon it. They are not, however, free from the possibility of injurious results.

Massage and gymnastics are useful in some cases, and certainly benefit has resulted from Frenkel's method of exercises. The patient is made to learn again the movements by the aid of vision; gradual transitions from simple to more complicated movements are practised under the guiding direction of vision, while he is lying, standing, and walking. When the patient is in an advanced state of locomotor ataxy, and when presumably the association systems of neurons of the spinal cord, as well as of the exogenous systems, are destroyed, little good can come from this mode of treatment; but prior to this, undoubtedly much benefit, and even a return of useful coördinate movement can in many cases be accomplished by a systematic adoption of this principle of opening up new paths and new associations under the direction of vision. Care must be taken, however, not to fatigue the patient.

It is of very great importance not to alarm the patient, yet at the same time to frankly confess that you are of opinion that he is suffering from an incurable disease, which will progress slowly or quickly according to his mode of life. If he gives himself up to indulgences *in Baccho et Venere*, and neglects the warnings as to exposure, fatigue, mental or bodily, the disease will certainly progress more rapidly. His general nutrition must be maintained by generous, but not excessive diet; iron, arsenic, or strychnine in the form of pill may be administered, if he suffer from anæmia or anorexia. He should be told to empty his bladder regularly; and not to allow more than four hours to elapse, so that atonic distension may be avoided. Care should be taken that he does not suffer from residual urine from want of use of a catheter, but the greatest precautions should be exercised to use a perfectly aseptic instrument. Smoking should be avoided if there is optic atrophy; in any case, moderation in tobacco should be strictly enjoined. He should be told that if he suffer with corns, he should not cut them, but soak them in warm water and carefully rub them down with pumice stone, otherwise he may suffer from a suppurating corn and perforating ulcer which will never heal. Owing to the liability to joint affections and spontaneous fracture, he should not attempt to walk without support, if he is ataxic; as a slight injury may lead to a serious result, in the form of spontaneous dislocation or fracture. It will thus be seen that the pathology of the disease teaches us that there are many symptoms and complications for which the doctor's aid may be called, and in relieving these and as far as possible comforting the mind of the patient and averting further morbid developments by judicious advice, he fulfils, as far as he is able, his duty towards the patient, for he is powerless to restore the nervous tissue which has been destroyed, and, indeed, is in great measure powerless to avert the progressive degenerative change of further nervous structures: in fact, there is no part of the nervous system which

may not be eventually affected in this disease; and the name of *Tabes* best expresses its character, and implies also that the treatment is symptomatic rather than curative.

Tabes Mesenterica. *See* Mesenteric Glands (*Tuberculosis of*).

Tabetic.—Relating to or affected by tabes, or, specially, with tabes dorsalis. *See* Amblyopia (*Diagnosis, Tabetic Blindness*); Auditory Nerve and Labyrinth (*Nerve-Deafness, Seat of Lesion, Tabetic Auditory Neuritis*); Osteo-Arthropathies (*Tabetic Foot*); Tabes Dorsalis.

Table.—In Surgery, the name given to the article of furniture on which the patient is placed for operation; in Anatomy, the name refers to the flat bone of the skull.

Tablespoon. *See* Prescribing (*Weights and Measures*); Metric System; etc.

Tablets.—Small, solid, disc-like bodies; lozenges or troches.

"Tabloid."—The form in which drugs are made up by Burroughs, Wellcome, and Co.; they may be plain, or sugar coated (when the drug is unpleasant), or coated with keratin (when the action of the drug is to be postponed till it reaches the intestine).

Tache.—A spot or freckle or discoloration (Fr.); *e.g.* the *taches cerebrales* or red lines left when the finger-nail is drawn over the skin in cases of meningitis, and the *taches bleuâtres* seen in typhoid fever. *See* Meninges of the Cerebrum (*Acute Simple Meningitis, Symptoms*); Meningitis, Tuberculous (*Symptoms*); Morphinomania (*Diagnosis, Needle Marks*); Typhoid Fever (*Complications and Sequelæ, Cutaneous System*).

Tachiol.—A preparation of silver fluoride, a solution of which has been used as an antiseptic in surgery and in eye work.

Tachy-.—In compound words *tachy-* (Gr. ταχύς, swift) means rapid, *e.g.* tachyphrenia (rapid mental action).

Tachycardia.—Rapid action of the heart. *See* Diphtheria (*Complications, Cardiac*); Gout (*Irregular, Circulatory System*); Heart, Myocardium and Endocardium (*Pathology, Hypertrophy*); Heart, Neuroses of (*Tachycardia*); Nose, Nasal Neuroses (*Vasomotor*); Thyroid Gland, Medical (*Exophthalmic Goitre, Symptoms*).

Tachyphrasia.—Great rapidity or volubility in speech; logorrhœa.

Tachypnœa.—Abnormally rapid respiration. *See* Hysteria (*Disorders of the Respiratory Organs*).

Tactile.—Relating to or belonging to the sense of touch; e.g. *tactile corpuscles* or *cells* (*see* Physiology, Neuro-Muscular Mechanism, *Tactile Sense*), *tactile aphasia* (*see* Aphasia, *Clinical Features, Tactile Variety*), and *tactile fremitus* (*see* Chest, Clinical Investigation of, *Palpation of Chest Wall*; Lung, Tuberculosis of, *Physical Signs of Consolidation*; Lungs, Emphysema of, *Physical Signs*; Pleura, Diseases of, *Acute Pleurisy, Signs*; Pneumonia, Clinical, *Physical Signs*).

Tactus.—The sense of touch, especially from the diagnostic point of view; e.g. *tactus eruditus*, the trained sense of touch developed by the specialist or experienced practitioner.

Tænia.—In Descriptive Anatomy, the term tænia is given to any band-like structure; *e.g.* the *tænia fornicis* of the brain, and the *tænia coli* of the large intestine. *See* Parasites (*Cestodes, Tapeworms*); Hydatid Disease.

Tænicide and Tænifuge.—Destructive to tapeworms; *e.g.* certain drugs, known also as vermifuges.

Tagliacotian Operation.—The Italian rhinoplastic operation, the flap for the formation of the nose being obtained from a distant part, *e.g.* the arm.

Tailed Infants. *See* Homo Caudatus.

Tailor's Spasm. *See* Neuroses, Occupation (*Etiology*).

Tait's Law.—The rule enunciated by Lawson Tait that in diseases of the abdomen and pelvis destructive to health or threatening life (except cancer), exploratory abdominal section should be performed.

Tait's Operation.—Lawson Tait's method of repairing the perineum; also, the removal of the ovaries and Fallopian tubes for other diseases than cysts. *See* Pelvis, Perineum and Pelvic Floor (*Perineal Tears, Operation*).

Takadiastase. *See* Malt; Enzymes (*Hydrolysing, Diastatic*).

Talalgia.—Pain in the heel.

Talipes.—Club foot. *See* Deformities (*Club Foot, Congenital, Acquired*).

Tallerman Method. *See* Hydropathy (*Hot Air Applications*).

Tallquist's Method.—A method of determining hæmoglobin percentages by comparing the colour of a blood spot on filter-paper with a series of standard tints.

Talma's Disease.—Myotonia acquisita, a non-hereditary disease characterised by tonic muscular spasm.

Talma's Operation.—An operative method of treating cirrhosis of the liver; omentopexy or omentosplenopexy. *See* Drummond-Morison Operation.

Talo-.—In compound words *talo-* (Lat. *talus*, the heel or ankle) means relating to the ankle or to the astragalus; e.g. *talo-calcanean*, *talo-tibial*, etc.

Tamar Indien.—A favourite preparation of senna (confection) coated with chocolate, and easily taken by children as a purgative. *See* Senna Indica (*Confectio Sennæ*).

Tamarindus.—The fruit of *Tamarindus indica* is a constituent of the *Confectio Sennæ* mentioned above and of the *Tamar Indien*; it contains citric, acetic, and tartaric acids, potassium tartrate, and sugar, and it acts as a mild purgative, suitable for children (dose, 1 dr.).

Tambour.—A drum-like instrument forming part of the recording apparatus in many physiological experiments, e.g. *cardiography*. *See* Physiology, Circulation (*Changes in the Position of the Heart*).

Tampon.—A plug or pledget consisting of cotton-wool, marine lint, or other material saturated in an astringent, sedative, or antiphlogistic drug, and inserted into one of the cavities (*e.g.* the vagina or nose). *See* Uterus, Inflammation of (*Treatment*).

Tannalbin.—A tannic acid preparation (*tannin albuminate*), forming a yellowish, odourless, and tasteless preparation whose action is on the intestine (*e.g.* in chronic intestinal catarrh); its dose is 15 grains as an intestinal astringent.

Tannic Acid.—Acidum tannicum, or tannin, or digallic acid ($C_{14}H_{10}O_9$, $2H_2O$), is a markedly astringent acid obtained from galls; it consists of glistening brownish scales, is soluble in water or alcohol, has an astringent taste and an acid reaction; its dose (when given internally) is 2 to 5 grains; there are three official preparations—*glycerinum acidi tannici*, *suppositoria acidi tannici*, and *trochiscus acidi tannici*; it is used both externally and internally as an astringent (coagulating albumen) and hæmostatic in many inflammatory and relaxed conditions (tonsillitis, pharyngitis, diarrhœa, ulcers, piles, skin diseases, urethritis, etc.), and as an antidote in poisoning by alkaloids and tartar emetic; its incompatibles are mineral acids, alkalies, alkaloids, gelatin, salts of antimony, lead, silver, and per-salts of iron. *See* Astringents; Prescribing (*Incompatibility*).

Tannigen.—Diacetyl tannin, an astringent, acting like tannalbin on the intestine below the level of the stomach, and used (dose, 10 grains) in chronic diarrhœa.

Tannin. *See* Tannic Acid.

Tanning.—An offensive trade (leather-making), regulated by the Public Health Act of 1875, by the Public Health (London) Act of 1891, by the Public Health (Ireland) Act of 1878, and by the Public Health (Scotland) Act of 1897.

Tannoform.—A condensation product of gallotannic acid and formaldehyde ($C_{29}H_{20}O_{18}$), which differs in its action from tannin by not uniting with the albuminoids in the stomach; it is used in intestinal catarrh (dose, 4 to 8 grains), and externally in burns, skin diseases, etc., as an ointment or dusting powder.

Tannone.—A condensation product of tannin and urotropin ($C_{48}H_{42}N_4O_{27}$), used in intestinal catarrh, etc., in doses of 15 grains.

Tannosal.—A combination of tannin and creosote, which is believed to be decomposed in the intestine into these two drugs and to have their effect

Tansy. *See* Toxicology (*Abortifacients*).

Tapeinocephaly.—The anomaly in cranial formation in which the vault is low and flattened (Gr. τἄπεινός, lying low).

Tapetum Nigrum.—A layer of pigment cells in the retina. *See* Physiology, Neuro-Muscular Mechanism (*Sense of Sight*, *Anatomy of the Eye*).

Tapeworms. *See* Parasites (*Cestodes*).

Taphephobia.—Morbid fear of being buried alive (Gr. τάφος, burial, φόβος, fear).

Tapioca. *See* Diet (*Roots and Tubers*); Invalid Feeding (*In Convalescence*).

Tapotement.—A form of massage or manipulation in which tapping of the skin is performed in various ways. *See* Massage.

Tapping.—Aspiration or paracentesis; drawing off fluid from a cavity, *e.g.* in ascites. *See* Ascites (*Treatment*); Meningitis, Tuberculous (*Treatment*); Ovaries, Diseases of (*Ovarian Cysts, Treatment*); Pleura, Surgical Affections of (*Paracentesis Thoracis*); Scrotum and Testicle, Diseases of (*Hydrocele, Treatment*).

Tar.—There are two official forms of tar. (1) The first is *Pix Liquida* or wood tar, which is obtained from various species of *Pinus*; it is a semi-liquid, brownish black in colour, and with a strong odour; the residue after distillation is pitch, a black solid; tar has many constituents, *e.g.* oil of turpentine, creosote, phenols, pyrocatechin, xylol, toluol, resins, etc.; if given internally, the dose is 20 to 60 m. (in pill form); there is one official preparation, *Unguentum Picis Liquidæ*. (2) The second form is *Pix*

Carbonis Præparata or prepared coal tar, obtained from commercial coal tar; it is made up of phenols, benzene, naphthalene, anthracene, and other hydrocarbons; and there is one official preparation, *Liquor Picis Carbonis* (closely resembling the well-known Liquor Carbonis Detergens). Tar is much used in the treatment of various skin diseases (chronic eczema, psoriasis, pruritus, etc.); internally it is little employed, but may be given as an expectorant in chronic bronchitis (as the Syrupus Picis Liquidæ or Vinum Picis of the U.S.P., or as the eau de goudron of the French). *See* Dermatitis Traumatica et Venenata (*Special Eruptions, Tar Workers*); Drug Eruptions (*Papular, Tar and Carbolic Acid*); Psoriasis, *Treatment, Local*).

Tar Camphor.—Naphthaline ($C_{10}H_8$). *See* Naphthaline; Naphthol.

Tarantulism or Tarantism.—Dancing mania; choreic movements which were ascribed to the bite of a tarantula (a large spider or *Tarantula apuliæ*).

Tarasp. *See* Balneology (*Switzerland, Alkaline*); Mineral Waters (*Alkaline*).

Taraxaci Radix.—Dandelion root (*Taraxacum Officinale*) contains taraxacin, taraxacerin, asparagin, inulin, mannite, salts, and resins, and acts like calumba and other bitters; there are three official preparations—*Extractum Taraxaci* (dose, 5 to 15 grains), *Extractum Taraxaci liquidum* (dose, ½ to 2 fl. dr.), and *Succus Taraxaci* (dose, 1 to 2 fl. dr.); it has been used as a stomachic in the same class of cases as calumba, and also in chronic congestion of the liver and spleen.

Tardieu's Spots.—Subpleural and subpericardial ecchymoses found in cases of death from strangling, and asphyxia from other causes. *See* Medicine, Forensic (*Death from Asphyxia, Post-mortem Appearances*).

Tarnier's Forceps.—French midwifery forceps to which Tarnier added the axis-traction rods, plate, and handle. *See* Labour, Operations, Forceps (*Compensation Curve*). Other obstetric instruments were invented by Tarnier; *e.g.* Tarnier's basiotribe (a combined perforator, basilyst crusher, and extractor) and Tarnier's cephalotribe (with *fenestrated* blades).

Tarsal.—Relating to the tarsus (Gr. ταρσός, broad or flat part) of the foot or of the eye; *e.g.* the tarsal arch, tarsal cartilage, tarsal glands, etc. *See* Eyelids, Affections of (*Anatomy*).

Tarsalgia.—Pain in the tarsus, often rheumatic, gouty, or associated with flat foot (*q.v.*).

Tarsectomy. *See* Deformities (*Talipes Equino-Varus, Treatment*).

Tarsitis.—Inflammation of the tarsus of the eyelid. *See* Eyelids, Affections of (*Affections of the Glands of the Lids, Tarsitis*).

Tarso-.—In compound words *tarso-* (Gr. ταρσός, broad part) means relating to the tarsus of the foot or of the eye; e.g. *tarsocheiloplasty* (plastic operations on the edge of the eyelid), *tarso-metatarsal* (relating to the tarsus and metatarsus of the foot), and *tarsotomy* (removal of tarsal cartilages).

Tarsorrhaphy.—A plastic operation on the eyelids to diminish their eversion. *See* Eyelids, Affections of (*Lagophthalmos, Treatment*).

Tarsus. *See* Ankle-Joint, Region of, Diseases (*Diseases of Tarsal Bones and Joints*); Eyelids, Affections of (*Anatomy, Sycosis Tarsi, Tarsitis, etc.*); Fractures (*Tarsus*).

Tartar, Cream of.—Acid potassium tartrate. *See* Potash.

Tartar Emetic.—Tartarated antimony or potassio-tartrate of antimony. *See* Antimony; Toxicoly (*Antimony*).

Tartaric Acid.—Tartaric acid or hydrogen tartrate ($C_4H_6O_6$) has the general action and uses of the acids, is very soluble in water, and is incompatible with potash, lime, mercurial and lead salts, and with vegetable astringents; its dose is 5 to 20 grains; it is much used for making effervescent drinks.

Tashkend or Tashkent Ulcer.—An endemic disease of Tashkend (Russian Turkestan), characterised by the appearance of an indurated red spot on the face, followed by ulceration; Sartian disease.

Taste. *See* Brain, Tumours of (*Localising Symptoms, Taste*); Ear, Middle, Chronic Suppuration (*Otitis Media Purulenta Chronica, Symptomatology*); Fifth Nerve, Affections of (*Affections of Taste*); Glosso-Pharyngeal Nerve (*Clinical Features*); Hysteria (*Sensory Disorders, Anæsthesia*); Mind, Education of the (*Senses, Education of*); Nose, Examination of the (*Sense of Taste*); Paranoia (*Progressive Systematised Insanity, Hallucinations of Taste*); Physiology, Neuro-Muscular Mechanism (*Sense of Taste*); Pregnancy, Affections and Complications (*Nervous System*).

Tattooing. *See* Skin, Pigmentary Affections of (*Spurious*).

Taupo. *See* Balneology (*New Zealand*).

Taurocholic Acid. *See* Physiology, Food and Digestion (*Bile, Chemistry*).

Taxis.—Manipulation (literally, arrangement, Gr. τάξις, from τάσσω, I arrange), especi-

ally for the reduction of a hernia or of a retroverted uterus. *See* HERNIA (*Strangulated, Treatment*).

Tay's Choroiditis.—Senile choroiditis, affecting specially the choroid round the macula lutea.

T-Bandage. *See* BANDAGES (*Made Bandages*).

Tea. *See* ANGINA PECTORIS (*Etiology, Alcohol, Tea, and Tobacco*); APPETITE (*Loss of, Causes*); CAFFEINA; DIET (*Beverages*); TEMPERATURE (*Diurnal Variations*).

Teale's Amputation. *See* AMPUTATIONS (*Through the Lower Third of Leg*).

Note.—The name is also given to an amputation of the arm and thigh with a long flap.

Teale's Grate. *See* VENTILATION AND WARMING (*Open Fires*).

Tears. *See* LACRYMAL APPARATUS, DISEASES OF; HYSTERIA (*Disorders of Circulation*).

Teaspoon. *See* PRESCRIBING (*Weights and Measures*); METRIC SYSTEM.

Technic or Technique. — The method of performance of any operation or test; the special details or modes practised by any operator; the practical part of an operation as opposed to the theoretical.

Tectocephaly.—An abnormal form of the head, due to early ossification of the sagittal suture.

Tectorium. A covering, *e.g.* the tectorial membrane of the organ of Corti.

Teeth.

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TEETH are hard, calcified organs of variable shape, size, and condition of calcification. In man and the mammalia generally, teeth are only developed in the mandible and maxilla, whereas in Reptilia and Pisces teeth are also found on the tongue, palate, pharynx, etc.

Teeth are derived from the epithelial tissues of oral cavity, epiblast, and mesoblast layers, and thus belong essentially to the tegumentary or dermal system. This analogy of the tissues is well exemplified in the lower vertebrates, where the gradation between teeth, bony plates, scales, spines, etc., is well shown. In some cases in the human subject deficiency of teeth is accompanied by want of, or deficiency of toe nails, finger nails, and hair.

Function and Forms of Teeth.—The principal function of teeth in most animals is to aid in the preparation of their food for digestion, or for holding or tearing their prey preparatory to swallowing. But they subserve other purposes: speech and appearance in man; attack and defence in the carnivora. The extinct Dinotherium, with its two long, curved tusks projecting downwards in the mandible, used them for digging up roots upon which it fed. The walrus helps itself along over the slippery rocks by means of its tusks, while the beaver, with its powerful jaw and chisel-shaped teeth, is able to cut down the hardest of trees with which to form its dam. The serpents use their teeth for retention of their victims, while the poisonous ones are also able to paralyse previous to swallowing; their teeth are also used for defence. The teeth of fishes are largely used for prehension, or for tearing their slippery prey. The function of some teeth is difficult to make out. For example, the wart-hog (*Sus Babirussa*), with its two recurved teeth passing upwards and backwards over its skull, which they some-

times penetrate. Layard's whale (*Mesoplodon*) has also a curious arrangement of teeth, which passes from the mandible upwards and backwards, crossing each other from left to right over the beak of the animal.

The forms assumed by teeth are very diverse. Teeth, or organs analogous, are found in the gizzard of the common crab and in some insects, notably the cockroach of our kitchens. In several of the Protozoa a complicated arrangement of tooth-like bodies is found. The garden snail has a crescentic jaw-plate in the roof of the mouth and the radula, a membranous ribbon bristling with teeth in the lower, the radula being used as a saw for cutting down leaves, etc., upon which it feeds. The whelk of our shores has its tongue or lingual ribbon bristling with a regular arrangement of sharp-pointed teeth. The echinus or sea-urchin has at the entrance to its oral cavity five sharp-pointed teeth, which are implanted in separate movable portions of the jaw. The teeth grasp the food, and it is then passed on to be ground down by the movable segments of the jaw. In the higher vertebrate fishes simple conical teeth abound, the highest form being found in the pike with its bristling array of strong, curved, pointed teeth, or in that of the wolf-fish (*Anarrhichas Lupus*) with its powerful jaws and caniniform teeth in front, for tearing from the rocks shell-fish, and its equally powerful, pavement-like, crushing teeth behind. In the skate family flattened plates generally represent the teeth, several of the rays having in addition a sharp-curved denticle growing out from the plate. The shark possesses a wonderful armament of teeth, composed of a series of triangular serrated flattened cones arranged tier upon tier, in the two jaws, and attached to the tough fibrous membrane covering them. Their teeth are constantly being renewed as the marginal ones drop off. The next row takes their place. This is brought about by the upward movement of the membrane carrying the teeth. Some of the extinct sharks had enormous teeth, and must have been very formidable animals. The myxine has a single pointed tooth in the palate, and two serrated plates upon the tongue. The tench has one grinding tooth on the occiput, opposed to which are two jaws in the pharynx below, which carry teeth. Some fishes have the bones of the fore-part of their head blended together, forming a kind of sharp-cutting beak. This is well shown in the globe-fish (*Tetrodon fahaka*). Other toothless fishes are the sturgeon, paddle-fish, etc.

Reptilia and Batrachia.—In this group of animals are found some remarkable forms of teeth, exhibiting, however, only a higher development of the cone. The teeth are neither so numerous, nor so widely distributed upon the bones of the oral cavity, as in fishes. Nearly all Batrachians and Reptiles have a constant succession of teeth, with the exception of some of the lizards (*Hatteria*). Generally, they possess two rows of teeth extending backwards beyond the line of vomerine teeth. The Australian lizard has broad, crushing spheroidal crowns to its teeth instead of points.

The toad is edentulous, while the frog has only one row of short teeth upon the margin of the maxilla; there are none present in the mandible. The teeth of the newt and salamander are very similar to those of eels, and are tipped with enamel. The siren has on its mandible a horny sheath and several rows of small teeth, while the maxilla is toothless. The extinct Batrachian Labyrinthodon was an enormous animal. It had rows of very large pointed teeth in the mandible and maxilla, and also palatine teeth. The structure of their teeth is most interesting. The whole tooth is made up of dentine, and presents a series of pulpules, with numerous dentinal tubules radiating from the centre of pulpule to the periphery, and intercommunicating with the systems in their neighbourhood, producing a most elaborate pattern when viewed by the microscope. Turtles and tortoises have no teeth, but the margins of their jaws are sheathed in horny cases. The vegetable feeders have blunted margins to their jaws, the carnivorous having sharp margins.

Crocodiles, gavials, and alligators have their jaws armed with powerful sharp conical teeth, which vary much in form and size in the different species. In the crocodile the number of teeth seems to remain the same throughout its lifetime, but they increase in size with age. The teeth are lodged in distinct sockets, and are constantly being renewed; the successional teeth in various degrees of development lie telescoped, one within the other, in the hollow root of the tooth, so that when one is broken or worn out, the next in succession replaces it. Among lizards there is great variation in the form of their teeth, some being blunt and rounded, others having thin serrated edges. The successional teeth are developed at their inner bases. The monitor lizard has a complicated arrangement of the pulp in its teeth, which divides into a number of processes at their base. Vascular dentine, so common in fishes' teeth, is likewise found in the teeth of some saurians. The enormous extinct Iguanodon had powerful palmate-shaped teeth—the inner side composed of vaso-dentine, the middle of dentine, while the other serrated surface is enamel only.

Aves.—None of the known species of birds possess true teeth, although numbers of them have tooth-like bodies on their mandibles, such as the motmot and toucan. The plant-cutters, Phytotomidæ, have, in addition, tooth-like bodies in the interior of their mandibles as well. Parrots in the fœtal condition are said to possess germs of teeth, which, however, disappear later

on. Of extinct birds there are several which had true teeth, as we learn from Professor Marsh. The Ichthyornis was described by him in 1872. Both jaws were furnished with compressed pointed teeth covered with enamel; there were forty-four in the mandible, and an equal number in the maxilla, and these teeth were fixed in distinct sockets. Another gigantic bird with teeth was the *Hesperornis regalis;* its teeth were planted in a groove extending the whole length of the mandible, and had sharp-pointed crowns covered with enamel, and supported on strong fangs.

Mammalia. — In nearly all the mammalia there are present definite sets of teeth, of constant number, form, and position. Some, however, only develop one set of teeth, and are called Monophyodont—the armadillo and sloth being examples. The larger proportion of mammals have a primary and secondary series of teeth; no animal, so far as is known, having more than two sets of teeth. Animals which have two sets of teeth are termed Diphyodont. The simplest form of mammalian tooth is found in the dolphin, with its numerous single-rooted, conical-pointed, homodont teeth, there being no successional teeth; it is also monophyodont. In the majority of mammalia the teeth present certain definite shapes which are characteristic of all of them. Thus, in the premaxilla there are present four single-rooted, cutting teeth incisors, then come the prominent canines, premolars, and molars, the latter of which subserve the purpose of grinding down food; dentitions like that of man are termed Heterodont. The typical mammalian dentition may be put thus: —I $\frac{3}{3}$ C $\frac{1}{1}$ Prm $\frac{4}{4}$ M $\frac{3}{3}$ = 44.

A peculiarity of some mammalian teeth is that of persistent growth. This is exhibited in the teeth of Rodentia—beaver, rat; also in the molars of the sloth, tusks of Babirussa, and elephant. Such teeth, though worn down at the point, continue to grow from the pulp at their base, and thus make up for loss. When from any cause the normal wear of the tooth is prevented, they sometimes grow so long as to prevent the use of the jaws, and death from starvation ensues.

Mammals may be roughly divided into classes thus: (1) Carnivora, (2) Proboscidea, (3) Ungulata, (4) Rodentia, (5) Edentata, (6) Marsupialia, (7) Insectivora, (8) Chiroptera, (9) Quadrumana.

Land Carnivora.—Dental formula, I $\frac{3}{3}$ C $\frac{1}{1}$ Prm $\frac{3}{2}$ M $\frac{1}{1}$ = 30. This type of dentition is well shown in the Felidæ, which have short powerful jaws, with strong muscular attachments; the incisors are small, so as not to interfere with the use of the sharp-pointed, prominent, trenchant blades of canines, which are used for seizing and killing their prey. The molar teeth have irregular ridges, and articulate with each other like scissor blades; they are used by the animal for removing the remainder of the soft tissues from the bones of their victims, and likewise for crushing the smaller bones. The other members of this family—dogs, cats, hyænas, racoons, and bears—all possess modifications of the same dentition adapted to suit their varied requirements and purposes.

Marine Carnivora.—The teeth of this group of animals are well exemplified in the dolphins and seals, with their long, narrow mouth, wide gape, and numerous subequal, conical, sharp-pointed teeth, well adapted for seizing and retaining their slippery prey. The dolphin has some 200 teeth in its jaws, which interdigitate with each other.

The walrus, *Trichechus Rosemarus* (dental formula, I $\frac{1}{0}$ C $\frac{1}{1}$ P $\frac{3}{3}$), has a very peculiar dentition, in the form of two enormous upper canines, which incline downwards beyond the lower lip. They are teeth of persistent growth, and are composed principally of dentine, with a thin coating of cementum. The walrus uses these great tusks in tearing from the rocks the shell-fish and seaweed upon which it feeds, and its tusks are also used to assist it in progression over the ice and rocks; the male is said to use them as sexual weapons. The sperm whale has a good armament in the mandible, of conical enamel-tipped teeth, some 40 to 60 in number, and only a few stunted teeth in the maxilla. The so-called toothless, or whalebone whale, in the fœtal condition, has present in both jaws a series of calcified teeth, which, however, are destroyed by absorption prior to birth. In the adult condition the baleen plates, which hang down from the palate, represent the teeth, each baleen plate being developed from a vascular papilla.

In the narwal (*Monodon monoceros*) only two canine teeth are found in the maxilla. In the female, although these teeth grow some 8 inches in length, they never erupt. In the male one tooth (rarely two) continues to grow from its persistent pulp till it attains the length of some 10 to 12 feet; this tooth is always the left canine, is quite straight, and is marked by spiral grooves, winding from left to right. The functions of this curious tooth are supposed to be for spearing fish upon which it preys; it is said also to be used for making air-holes in the ice during winter.

Proboscidea. — There are only two living representatives, the Indian and African elephants.

Indian elephants have two tusks, incisors, in the maxilla, composed principally of dentine, the ivory of commerce. They are less in size in the female than in the male; they have molars $\frac{6}{6}$, which are very large, and are composed of irregular parallel plates of enamel and dentine, fused together with cementum from before backwards; the enamel plates number

from 4 to 27. African elephants differ in many respects from Indian. The tusks are large in both sexes; the molar teeth present lozenge-shaped plates, and the number of plates is very much reduced. Of extinct Proboscidea the well-known mammoth, *Elephas primigenius*, possessed two enormous tusks 8 feet long, strong, thick, curving upwards and backwards, and altogether was a much larger animal than any known elephant. The mastodon, another extinct animal, resembled the elephant, the molars, however, being much simpler in character, more tubercular, and free from cement. It had two small tusks, incisors, in the mandible.

Ungulata. — As examples of this class we might take the horse. Dental formula, I $\frac{3}{3}$ C $\frac{1}{1}$ Prm $\frac{4}{4}$ M $\frac{3}{3}$ = 44. The incisors present a curious dipping down of the enamel, constituting the pit or peculiar mark, from which horse-dealers are able to tell the age of any animal they inspect—the regular rate in which it is worn down in the different incisors indicating this. This mark is due to the inflection of the enamel, or a raising up of the singulum. The incisors meet with an edge to edge bite, causing a rapid wearing away of the teeth. The molars are long and strong, the enamel plates assume very intricate patterns, the interspaces being filled up with cementum. As the teeth get worn down they continue to grow, though they have not persistent pulps.

Rhinoceros.—Dental formula, I $\frac{2}{2}$ C $\frac{0}{0}$ Prm $\frac{4}{4}$ M $\frac{3}{3}$. This dentition differs in many respects from that of the horse. The molars are of very intricate pattern, though not so complex as that of the horse, and present a rough, raised surface admirably adapted for grinding the tough roots, etc., on which it feeds.

Wild Boar.—Dental formula, I $\frac{3}{3}$ C $\frac{1}{1}$ Prm $\frac{3}{3}$ M $\frac{3}{3}$ = 40. The upper incisors stand apart from each other. The same teeth in mandible stand straight up in an almost horizontal position; the canines are large, conical, and prominent, and have persistent pulps. The maxillary ones incline downwards, then outwards and upwards; the lower ones, outwards and upwards; the molars increase in size from before backwards, their masticating surfaces presenting rounded conical cusps. Another member of the family, *Sus Babirussa*, is remarkable not only for having enormously long maxillary tusks, canines piercing the upper lip, and curving upwards and backwards, but also for the curious structure of their last molar teeth; these are very massive and composed of prisms of enamel, surrounding a central mass of dentine, embedded in the cementum which unites them into one tooth.

Rodentia.—The capybara is the largest rodent. The molars and incisors grow from persistent pulps. Molars $\frac{4}{4}$ are large in size, and are composed of a series of irregular plates of dentine and enamel fused together with cementum. The incisors are long and scalpriform, and have persistent pulps. Enamel is only present on the front surface of the tooth, which keeps the tooth always sharp, by the wearing away of the softer dentine behind. In hares and rabbits the molars have persistent pulps, but in cats, mice, and beavers the teeth have roots; there is a wide diastema between the incisor and molar teeth, and sometimes between premolars and molars.

Edentata.—This name is given to animals in which there are no incisors present in the intermaxillary bone. Though true of most of them, a few have upper incisors, the centrals in all cases however being absent. As a rule, the dentitions in this group are homodont or monophyodont, except the two-toed sloth. The teeth are very simple in form, and do not differ to any extent, except in size, in the various parts of the mouth. The teeth have persistent pulps, and consist chiefly of dentine and vaso-dentine. The armadillo has on an average some 32 teeth; priodon, 100 teeth. Sloths have 18 teeth, principally composed of vaso-dentine.

Marsupialia.—The typical marsupial dentition is I $\frac{3}{3}$ C $\frac{1}{1}$ Prm $\frac{3}{3}$ M $\frac{4}{4}$ = 44. They are peculiar in having only one deciduous tooth, a molar on either side of the jaw. They all possess tubular enamel except the wombat. The dental formula of this animal is I $\frac{1}{1}$ C $\frac{0}{0}$ Prm $\frac{1}{1}$ M $\frac{4}{4}$ = 24. Its dentition greatly resembles the rodent type. Like them it has large chisel-shaped incisors, covered with cementum, and with long fangs growing from persistent pulps; its molars also are of persistent growth, and it has no deciduous teeth.

Insectivora.—The best-known animals in this class are hedgehogs, shrews, moles, and flying lemur. In the hedgehog the dental formula is I $\frac{3}{3}$ C $\frac{0}{0}$ Prm $\frac{4}{3}$ M $\frac{3}{3}$ = 38. In the maxilla there is a wide space between the central incisors, which are caniniform in shape and larger than the others; all the other teeth up to the third molar resemble premolars in shape. The fourth premolars and the three molars have strong square crowns, with four well-defined cusps, and have each four roots. In the mandible the teeth present similar appearances, but are rather smaller in size. Another member of the family, the flying lemur, *Galeopethicus*, has a very curious dentition. The mandibular incisors are divided by a number of longitudinal divisions, giving an appearance similar to that of a comb. It has a well-marked primary dentition. The teeth of Insectivora have all a very thick coating of enamel, and pigmentation of this tissue is well marked.

Chiroptera are divided into Insectivorous and Frugiverous. Dental formula of first, I $\frac{2}{3}$ C $\frac{1}{1}$ Prm $\frac{3}{3}$ M $\frac{3}{3}$ = 38. The insectivorous bats have very small incisors, rather large canines and premolars; the molars are covered with sharp cusps similar to insectivorous teeth; some

develop milk teeth, others do not. The vampire bat, *Desmodus*, has a specially modified dentition. It has only one incisor on either side, which is large, but thin and sharp edged, and with which the wound is made. The inferior incisors are small and slightly notched, the canines large, but the posterior teeth are somewhat dwarfed. Frugiverous bats, dental formula, I $\frac{2}{2}$ C $\frac{1}{1}$ Prm $\frac{2}{3}$ M $\frac{3}{3}$. The teeth have a diastema between them, the incisors small, canines rather large; both premolars and molars are of a simpler form, slightly compressed, and have slight cusps on their outer surface.

Quadrumana. — This group embraces lemuridæ, lemurs, simiidæ, old and new world monkeys, anthropidæ, man. The lemur is a native of Madagascar, and its dentition differs somewhat from that of the monkeys. The majority of them have the maxillary incisors very small and widely separated from each other. In the mandible there are present four long, thin, narrow, incurved incisors, and two canines; the premolars are narrow, sharp teeth, the molars armed with long sharp cusps. The maxillary molars in many lemurs have four cusps connected by an oblique ridge, as in man and monkeys. A curious member of this family, which, both in appearance and in its dentition, approaches closely that of the rodent, is found in the aye-aye (*Chiromys*). It has a pair of narrow, curved upper and lower incisors, which grow from persistent pulps. Owing to the obliquity with which they strike each other, and the absence on the lingual surfaces of enamel, the edge of the teeth, like the beaver's, is always kept sharp. There is a considerable diastema between the incisors and the next teeth present in the jaws, which have the appearance of molars—four maxillary and three mandibular; they are rooted teeth, are not of persistent growth, and resemble the molars of rodents. The deciduous dentition present in the animal, which differs entirely from the rodent type, proves its lemurian origin.

Simiidæ are divisible into two groups: the old and new world monkeys. The latter differ in many respects from the old world monkeys, notably in their dental formula, which is I $\frac{2}{2}$ C $\frac{1}{1}$ Prm $\frac{3}{3}$ M $\frac{3}{3}$ = 36. In a large number of the members of this family the anterior and posterior cusps of the molars are joined by an oblique ridge. The old world monkeys have the same dentition as man, I $\frac{2}{2}$ C $\frac{1}{1}$ Prm $\frac{2}{2}$ M $\frac{3}{3}$ = 32, with some modifications as regards size, shape, and arrangement of roots. The anthropoid apes which approach nearest to man are the orang and gorilla. In the orang the centrals are larger, the laterals somewhat caniniform in shape, the canines stronger and much longer than any other tooth, and are less in size in the female. The first maxillary premolar is caniniform, with a large outer cusp and small inner one, a ridge of enamel uniting the two. The second premolars are three-rooted. The mandibular incisors are large and strong teeth; the first premolar has scarcely any appearance of an inner cusp; the second premolar has a well-developed inner cusp. The molars are similar to those of man. Although the gorilla has a configuration very like man, the dentition differs considerably. The jaws are massive, and there is a considerable space between the maxillary incisors and canines. The first mandibular premolar is shaped like a canine, and the third molar is the largest of these teeth, differing from man. The maxillary canines in the male appear after the eruption of the third molar, and are about half as long again as any of the other teeth, being used as sexual weapons. All the Quadrumana have well-marked dentitions. Teeth of man, I $\frac{2}{2}$ C $\frac{1}{1}$ Prm $\frac{2}{2}$ M $\frac{3}{3}$ = 32. Deciduous, I $\frac{2}{2}$ C $\frac{1}{1}$ M $\frac{2}{2}$ = 20. The maxillary central incisors are the largest; the anterior approximal surfaces are longer than the distal, making the inner angle more acute than the outer, the labial surface is concave, the lingual convex, the root is cylindrical, tapering from the neck to the apex. Lateral incisors are smaller, the distal surface is rather concave, the mesial convex, while the shape of the root is similar to that of a central. Lower central incisors are smaller than the upper, and are also smaller than the lower laterals; the distal angles are only slightly rounded off, differing from the upper; the roots are much compressed laterally; maxillary canines, labial surface convex both ways. There is a well-marked longitudinal ridge, dividing the tooth into two unequal parts; the cutting edge at the mesial part is sharp, the distal sloping gradually. The roots are large and cylindrical; the lower canine is somewhat smaller in size, and the root more compressed from side to side. Premolars: upper larger than the lower, labial surface greater than the lingual; there are two well-marked cusps separated by a transverse fissure. This tooth usually has two roots. Second premolar resembles the first, excepting the root, which is generally single. First mandibular premolar: the inner cusp is considerably smaller than the outer; its root is somewhat rounded. Second premolar: the inner cusp is larger than the outer; the outer distal side is often thickened, giving it the appearance of three cusps; the root is the same as the first premolar. Molars: maxillary somewhat square in shape, with rounded edges on the grinding surface; there are four well-marked cusps; the antero-internal is the largest, being connected by an oblique ridge with the postero-external; there are two fissures between the cusps, buccal and lingual. These teeth have three roots—palatine, anterior, and posterior buccal. Third molars vary greatly in shape and size; the roots are usually fused together; it has three cusps, two of which are buccal.

Genesis of the Teeth

At about the seventh month of intra-uterine existence there is observed, on making transverse sections, in the neighbourhood of the future alveolar borders, a dipping down and proliferation of the oval epithelium. Later on little processes begin to dip down into the submucous tissue. These processes at their extremity assume a rounded appearance, increasing gradually in size and breadth; at the same time the bulbous portion at its deepest part becomes concave, the inner surface of which is lined with columnar cells, from which the enamel of the future tooth originates (Fig. 1). In the submucous layer there is now noticed an uprising of this tissue, which pressing upwards moulds itself to and is surrounded by the con-



Fig. 1.

cave surface of enamel germ. This is the dentinal germ. From the base of this dentinal germ there originates a capsule of fibrous tissue, the sacculus, which gradually surrounds the developing tooth, and eventually cuts off the neck of the enamel organ from the mass of epithelial cells. The inner layer of the sacculus at a later period forms the cementum and peridental membrane of root. Each enamel organ is thus composed of a sort of cap surmounting the dentine germ. The former is connected by a narrow epithelial band (the neck of the enamel organ) with the oral epithelium; part of this band eventually forms the enamel germ of permanent tooth. The dentine germ consists of fine connective tissue nucleated cells and blood-vessels, which anastomose freely; later on nerve fibrils are also formed. The external layer of cells and odontoblasts which form the dentine are nucleated or columnar in form, and collectively are called membrana eboris. The enamel organs of the central, lateral, canine, first and second molars appear in succession during the seventh week of fœtal life, their respective dentine germs during the ninth week. The calcification of the central lateral incisors and canines commences at the seventeenth week of embryonic life, that of the first and second molars a week later.

Eruption of Teeth.		*Primary.*
7th month	. .	Central incisors.
7th to 10th	,, . .	Lateral incisors.
12th to 14th	,, . .	First molar.
14th to 20th	,, . .	Canine.
18th to 36th	,, . .	Second molars.

At five years of age the deciduous teeth at several parts of the roots are attacked by absorption and gradually destroyed, to make way for their successors. This is brought about by the osteoclasts, multinucleated cells, which attack the root, producing irregular excavations —lacunæ of Howship.

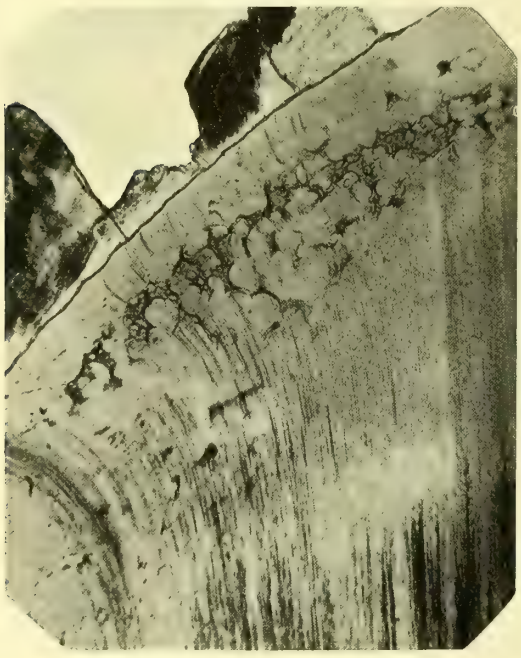
Permanent.—Teeth of the mandible usually precede those of the maxilla by a short interval. The enamel germs of the permanent teeth are budded off from the necks of the enamel organ of corresponding primary teeth. The first molar has its origin from the oral epithelium, the second from the first, and the third from the second.

6½	years . .	First molar.
7	,, . .	Central incisors.
8	,, . .	Lateral incisors.
9	,, . .	First premolar.
10	,, . .	Second premolar.
11-12	,, . .	Canine.
12-13	,, . .	Second molar.
17-25	,, . .	Third molar.

These dates are only approximately correct,

as any taint—such as rachitis, struma, or syphilis—hinders the eruption of the teeth.

The greater mass of a tooth is composed of dentine, the root being coated with cementum; the crown has a cap of hard enamel, which at the neck is somewhat overlapped by the cementum. Enamel contains from 1 to 3 per cent of animal matter in the adult, but a larger proportion is present in the teeth of the young. It is composed of striated fibres or prisms running parallel with each other, and at right angles to the surface of the dentine its inner surface unites with the dentine. Enamel is the hardest tissue of the body, but does not attain its full hardness till some time after the eruption



Faulty enamel and dentine.

FIG. 2.

of the tooth. Defects in this tissue are fissures and a granular condition of the prisms (Fig. 2).

Dentine.—Human dentine is yellowish white, hard, and unvascular, and in structure consists of an organic matrix permeated with parallel tubes, which radiate from the pulp chamber to the periphery of the dentine, gradually decreasing in size, and giving off small intercommunicating branches as they pass outward. The size of a dental tube is $\frac{1}{4500}$ to $\frac{1}{10000}$ in. Dentine consists of 28 parts animal and 72 parts earthy matter. The walls of the tubes are composed of calco-globulin, and are very resistent to the action of acids, etc. The contents of the tubules, according to Beale Tomes, are processes of odontoblast cells, or of the cell beneath (Klein); they seem to have the property of transmitting sensation to and from the pulp. Faults in dentine are interglobular areas and contour markings which are due to faulty calcification of the tissue, or want of coalescence of the calco-spherites, leaving their contours still visible, and is a condition which favours the spread of dental caries (Fig. 2).

Cementum.—In human teeth the roots only have a thin coating of cementum, but in many animals the crown also is covered with this tissue. In newly erupted human teeth the membrane called Nasmyth's covering them is said to be composed of a thin layer of cementum. Cementum consists of a calcified, laminated basis substance, containing lacunæ and canaliculi. The lacunæ are more irregular in size, shape, and distribution than those of bone, and their canaliculi are most numerous next the peridental membrane. Sharpey's fibres, calcified bundles of fibrous tissue, are also found in the cementum. When from any cause the peridental membrane covering the root is irritated, layer after layer of cementum is deposited on the root, constituting the disease called exostosis. As a rule, there are no Haversian canals in cementum. The peridental membrane covering the root of a tooth is composed of a highly vascular connective tissue membrane, abundantly supplied with nerves, which are derived from the pulps, submucous tissue, and from those of contiguous alveolar wall.

Dental Caries

Dental caries, so prevalent in the present day, is not by any means a disease of modern times, but evidently prevailed to a considerable extent among ancient nations, Romans, Grecians, etc. Some of the lower animals also suffer from this affection, especially domesticated animals. Curiously enough, monkeys seem to be immune from dental caries, though their teeth are so much alike, both in shape and structure, to those of man. Dental caries may be defined as a gradual disintegration of the tooth substance, the lime salts being dissolved and broken up by the numerous micro-organisms which live on and assimilate the organic matrix of the tooth after the tissues are softened. The older writers considered caries to be an inflammatory process; others, that it was clearly a chemical process, etc. The first indication of caries is exhibited by the enamel, which assumes a whitish, opaque, or chalky appearance; the dentine, on the other hand, when softened becomes translucent, and frequently is pigmented of a brownish colour due to bacteria; the lighter the colour of the softened dentine the more acute and rapid the caries, the darker the carious tissue the slower it advances, and it is in such

cases, on the masticating surface of a tooth for instance, where caries is sometimes arrested and the surface gets smooth and polished. Such

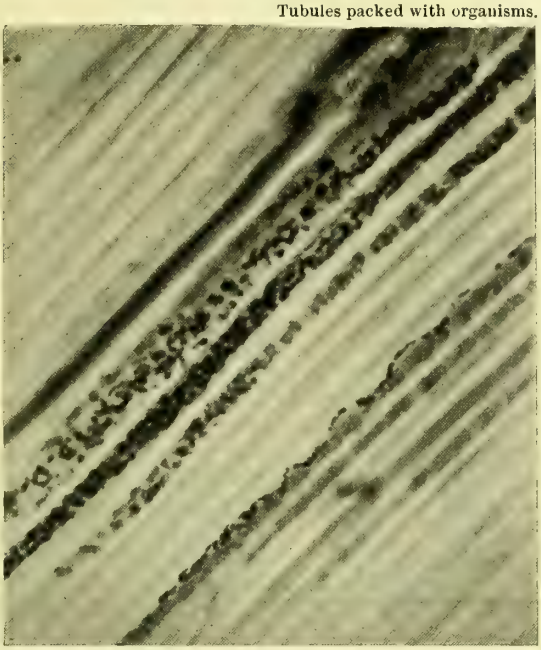


FIG. 3.—Section of carious dentine.

terms as spreading, peeling, and penetrating are applied to the different varieties of caries, but they are all the result of the structural peculiarities of the tooth when infected. Caries usually originates in some fault or fissure in the enamel, in which micro-organisms find lodgment, and once the dentine is reached they rapidly penetrate the dentinal tubules, softening and breaking them up till the pulp is reached. Microscopic examination of a stained section from a carious tooth exhibits the tubules packed with micro-organisms, micrococci, bacilli, or bundles of leptothrix filaments (Figs. 3, 4, 5). The latter organism is always present in all carious cavities, growing like a fringe from the walls, but less frequently penetrating and proliferating in the tubules. Sometimes uninfected tubules may be found in the midst of infected ones. Professor Miller of Berlin, in 1882, by a series of elaborate experiments, was the first to demonstrate the true pathology of dental caries, and succeeded in producing artificial dental caries in sound teeth, by subjecting them to a mixture of saliva and bread kept at a constant temperature, changing the fluid whenever it became alkaline. Other investigators, Leber and Rottenstein, Coleman Miles and Underwood, and Magitot later on, were able to show somewhat similar results.

Causes of Dental Caries.—These might be divided into local and predisposing. The local are anatomical defects: interglobular spaces, fissures, accessory cusps, etc., all favour the production of caries, while a vicious arrangement of the teeth in the arches, hindering their proper cleansing, is an all-important factor in the predisposition to caries of the teeth. Vicintini and Leon Williams have both within recent years demonstrated and described the presence on and adherent to the teeth of gelatinous plaques of organisms called Leptothrix racemosa, which generate lactic acid, and attack any weak spot in the enamel, opening up a way for invasion of the dentine. Deficiency of lime salts in a tooth was supposed to be a potent predisposing cause in the production of caries, but from recent chemical researches by Black, confirmed by Tomes, it has been found that carious teeth frequently contain a larger proportion of lime salts than sound teeth, which seems to disprove this. This point, however, has not been proved, for, as Dr. N. Bennett says, the physical and molecular constitution require to be taken into consideration as well as the chemical ere this could be settled decisively.

Predisposing Causes.—Pregnancy, as is well known, has an injurious influence on the teeth, due to acid conditions produced by alteration of the oral secretions, as a result of dyspepsia, etc., occurring at this time. It is well recognised that acid conditions usually prevail, especially in first pregnancies, and these, aided by impaired nutrition, have a decided effect on the teeth,

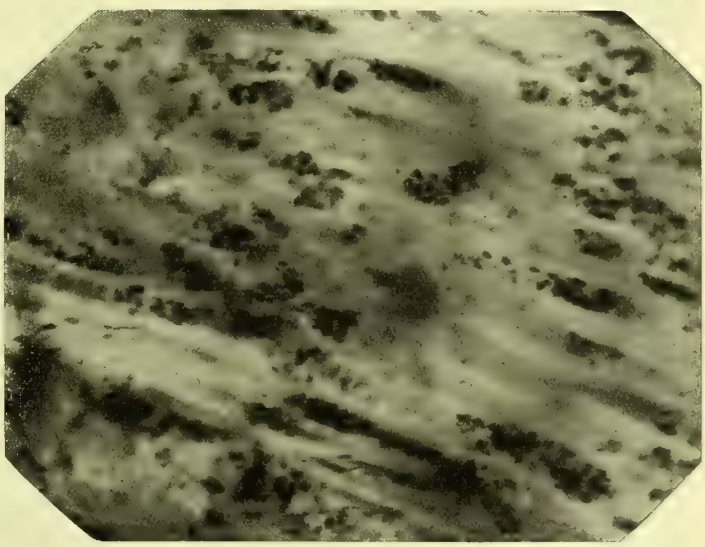


FIG. 4.—Section of carious dentine. Tubules filled with sarcinacoccus which has distended and broken them up

especially if weakened by structural defects or previous disease, and as a frequent result severe odontalgia or neuralgia is induced. The oral mucous membrane when irritated and inflamed, as it very often is in the pregnant condition, secretes acid, and this along with acid eructations have an injurious effect on the teeth. Likewise the fact that owing to the tendency to retch and besick the teeth are often neglected at this period. It is frequently found after pregnancy that the pulps of filled teeth have become atrophied or gangrenous as a result of the impaired nutrition incident to this state, eventuating in alveolar abscess, and it may be septic local conditions. In the state of typhoid, tuberculosis, or any of the exanthemata, where vitiation of the oral secretions prevails, there exists a state of matters favourable to the development and progress of dental caries, and it is well known

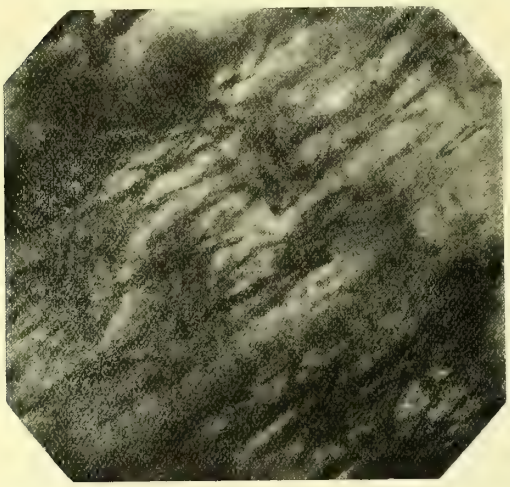


FIG. 5.—Section of carious dentine. Leptothrix fibres in tubules of dentine.

and expected, that after an attack of say typhoid, the teeth generally are found affected by caries, although they had given no trouble prior to this. There seems to be a greater tendency to caries between the ages of 12 and 30. Two reasons may be given why this is so: one is that the teeth of young people contain a larger amount of animal matter, making them more susceptible to attack; and, second, the teeth as a general rule are not cleansed so well as they might be, while the amount of fermentable matter in the shape of sweets, etc., taken must act injuriously on the teeth. With age the teeth get harder and less susceptible to caries.

Diet in Relation to Caries.—It has been found that diet has an important bearing in respect to dental caries, as it has been found that people living principally on farinaceous foods suffer most from caries, while flesh-feeders are not so prone to it, the mastication of the tough fibrous material cleansing the teeth, and though it finds lodgment about the teeth and decomposes, the product is alkaline, whereas the soft farinaceous foods get packed in between the teeth and into fissures, fermenting and producing acid conditions favourable to the spread of caries. Dr. W. Wallace, in a paper recently read by him, attributes the prevalence of caries in the present day to the elimination from our food-stuffs of the fibrous tissue, the large amount of starch food used, and the over-cooking of our animal food, giving the teeth and jaws so little to do, it being well known that organs not used are liable to degeneration. The great increase in the prevalence of dental caries in Great Britain within recent years led the British Dental Association in 1890 to appoint a committee to investigate the condition of school children's teeth, and from the valuable reports issued yearly up to date we learn that a considerable advance has been made in the education of public opinion, and in furtherance of the supervision and treatment of school children's teeth; but much remains to be done, and it is to be hoped that ere long all board schools and others will have dental surgeons appointed to them, to look after and treat the teeth of those who are to take our places as soldiers, sailors, mechanics, merchants, etc., who will enter life poorly equipped indeed if deficient in teeth, or constantly laid up, as a result of diseases, local or general, due to septic conditions produced by numerous bad teeth. The late war has drawn attention to the numerous rejections of otherwise fit recruits, both in the army and navy, owing to defective teeth. A recruit must have ten sound teeth in either jaw to be eligible for enlistment; after enlistment not the slightest attention is paid to the teeth, which is very bad policy, and makes the primary precaution of no avail. To remedy matters, it would be well for the Government to appoint dental surgeons to the various military and naval depots, whose duty it would be to examine recruits' teeth (an expert only can tell whether a tooth is savable or not), and do the necessary operative work, inculcating on the patients at the same time the necessity of keeping their mouths in a sanitary condition by regular daily brushing of the teeth.

Condition of the Saliva in Dental Caries.—The saliva in bad cases of dental caries is frequently found thick, sticky, and of an offensive odour. In gout, rheumatism, and diabetes the saliva is strongly acid, and as this acid is usually lactic, we can understand that this would injuriously affect weak teeth, while the presence of a large or small amount of sulphocyanide of ammonia in the saliva is said to prevent or retard dental caries. It is not definitely known whether in alkaline conditions of the saliva dental caries can progress, but it has been pointed out that some micro-organisms which are capable of softening dentine have alkaline products.

The opinion was held by most of the old pathologists that human saliva had poisonous properties. The writings of Habdarrhamus, Ætius, Machiafava, etc., show this. But the first authors who referred the toxic effects of mixed saliva to the influence of bacteria were Raynaud and Lannelonque, who produced septic poisoning in rabbits by inoculating them with the saliva of a child affected by hydrophobia. Pasteur, who also tried the same experiment, thought that hydrophobia had been induced, but Colin disproved this. Vulpian shortly after this demonstrated that the same condition could be produced by inoculating with healthy saliva, and other experimenters pointed out that the poisonous effects were due to the presence in the mixed saliva of micro-organisms, as sterilised saliva had little or no effect on animals experimented with.

Klein (1884) drew attention to the infectious properties of human saliva, particularly in diseased conditions of the oral cavity, showing beyond doubt that large numbers of pathogenic organisms in the shape of cocci were present in the saliva, which if taken up into the circulation in any number might produce very serious diseases. The mixed saliva of the mouth is a compound of saliva, mucus, and micro-organisms. It is generally alkaline after eating; after prolonged fasting or talking, however, it is generally acid. Wright (1844) gives some interesting information in regard to this. He says the acidity of the saliva in different diseases is due to the presence of various acids. Lactic acid is found in gout, rheumatism, intermittent fever, gastro-enteritis, and diabetes, acetic acid with aphthæ, scrofula, scorbutus, smallpox, dyspepsia, and after the use of acid wines, HCl in connection with simple gastric disturbances. Alkalinity of the saliva occurs in consequence of the presence of an excess of soda. It is considered to imply, pathologically, general or local disturbance of the nerves. The local affections of the nerves comprise facial neuralgia and odontalgia, dependent on irritation of the pulp without inflammation of the peridental membrane of the root and adjacent tissues. The alkalinity frequently is an important aid in diagnosis, inasmuch as the purely nervous facial pain is accompanied almost always by an alkaline, and the rheumatic pain by an acid saliva. It is not definitely known whether in alkaline conditions of the saliva dental caries can progress, but it has been pointed out that some micro-organisms which are capable of softening dentine have alkaline products. Attention within recent years has been drawn to the importance of a knowledge of the conditions of the salivary secretion as a method of diagnosing nutritional and diasthetic conditions of the body. At the International Medical Congress in 1901 Dr. J. C. Michaels pointed out that the salivary secretion was of more importance as a method of diagnosing diseased conditions than even urine, since the saliva holds in solution all the crystallisable substances which are the waste products of nutrition, and which, by reason of their crystalline and soluble character, are dialysable through the structure of the salivary gland. In a bad case of neurasthenia which came through my hands recently attention was drawn to the peculiar condition of the salivary secretion, which was so thick and viscid as almost to preclude the patient from spitting it out of his mouth. In cases less pronounced than this, where the secretion is thick and stringy and exhibits an acid reaction, we always find dental caries progressing at a very rapid rate, indicating to us the necessity of prophylactic measures being used.

Prevention of Caries.—The mouth forming as it does an efficient incubator for the various micro-organisms, it is essential that treatment should be on antiseptic lines. All carious teeth should be treated and filled, while all roots unsavable should be removed, as they are just a source of infection to the other teeth. If the teeth in maxilla and mandible are overcrowded, it is advisable, especially in young people, to extract the four first molars, and it is wonderful how quickly the spaces fill up and relieve the overcrowding. It is requisite that an antiseptic and antacid dentifrice should be daily used with the tooth-brush, especially at night, to prevent the active fermentation which would otherwise take place in an uncleansed mouth during sleep. Such a dentifrice as this might be used:—℞ Pulv. creta praec. ℥ij., magnesiæ carb. ℥ij., oil cinnamon 40♏, misce bene, after which the mouth might be rinsed with Phillips' milk of magnesia, a valuable alkaline antiseptic. That proper cleansing of the mouth and teeth has a beneficial effect is demonstrated by the fact that material taken from a well-brushed mouth and used to obtain a culture from produces very few organisms compared with that from an unclean mouth. Children should be early taught to brush their teeth regularly every night, and the necessity for it explained to them, and in all cases of rapid destruction of the teeth by caries the use of Phillips' milk of magnesia, the last thing at night, will greatly help to retard and control the advance of this disease.

Treatment of Caries.—In the treatment of simple caries two methods are employed. The removal of the diseased tissue, with as much of the surrounding healthy parts so as to leave a smooth and self-cleansing surface, constitutes one method. The removal of the carious tissue, and the replacement of the lost tissue by some indestructible material, the second method. Excision should only be carried out on incisor teeth very slightly affected on their approximal surfaces, the tissue being removed more especially from their lingual approximal surfaces by means of diamond discs or other appropriate

instruments, and the surfaces carefully polished, and this operation should only be carried out in healthy mouths and on teeth of good quality. Perhaps no operation on the body is so successful as that of tooth filling, restoring as it does the tooth to its original size and function. Various substances are in use for filling teeth—cements, oxyphosphate of zinc, guttapercha, amalgam, tin and gold foil, porcelain fillings. Before introducing any filling material the carious tissue must be removed and the cavity shaped to retain it, sharp excavators or burs are used, and all thin and overhanging enamel edges removed. Choquet has shown that caries can progress below a tight filling, and more especially would this be the case if any softened carious tissue is left. The oxyphosphate cements are useful, being somewhat non-conducting, and adhere closely to the walls of the tooth cavity, but are more or less rapidly dissolved by the secretions of the mouth; they are very useful in lining sensitive cavities, inserting a metallic filling on the top. A recent introduction, oxyphosphate of copper, which possesses antiseptic properties, promises to be useful, especially for temporary teeth. Guttapercha is a most useful filling in cases of hypersensitive teeth, and it is the only filling that is of any avail in some such cases; the variety that lasts best in the mouth is pink in colour, and is sold for making base plates; its non-conductivity is an important factor, and it seems to get harder in the mouth after insertion, and lasts remarkably well even on masticatory surfaces. Amalgams, which consist mainly of tin, silver, or gold in various proportions, are extensively used in filling teeth, but should only be used in posterior teeth owing to their tendency to discolour the teeth. Copper is sometimes added also, so as to get antiseptic effects. The amalgam reduced to filings is triturated in a mortar with mercury, and a stiff paste formed, which is piece by piece introduced into the dried and sterilised cavity till it is packed quite full, and it usually hardens in an hour or two. In deep cavities near the pulp it may be necessary to line with guttapercha or cement first, to prevent the conduction of changes of temperature through the metallic filling from irritating the pulp, as it has a tendency in some cases to do. A mixture of cement and amalgam filling is sometimes used for sensitive or fragile teeth. In filling teeth with whatever material it is essential that the saliva be excluded from the cavity, as it is laden with micro-organisms. A sheet of thin rubber is used largely for this purpose. A series of round holes suitable in size for the teeth it is desired to protect are punched in the material, and each one slipped over the tooth and forced close up to the neck of the tooth, tying it in place with a piece of waxed silk thread: this absolutely excludes moisture, and enables the operator to treat antiseptically or otherwise teeth requiring such treatment. Saliva ejectors, for the removal of the saliva, may be employed also, or rolls of cotton-wool, etc.

Gold Filling.—This material is more usually employed than almost any other, the gold being introduced into the cavity, and welded by special instruments serrated at their points, pressure being applied by the hand, or by means of an automatic mallet or electric plugger. The gold is used in the form of cohesive or non-cohesive foil in the shape of ropes, pellets, cylinders, etc. Cohesive gold is obtained by heating to a dull red any form of pure gold, and a filling can be built up so as to replace the lost portion of a tooth. Generally two little pits are drilled at each angle on the base of the cavity, which are filled up with gold and bridged over, forming the foundation of the whole superstructure. The whole surface, on being finished and contoured, is smoothed and burnished with sand-paper discs, etc. Non-cohesive gold is used mainly in the form of cylinders which are packed and wedged against one of the walls of the cavity, filling up till quite full, and, to obtain a harder surface, it is usual to finish up with cohesive gold. The great objection to gold and amalgam fillings are their unsightly colour, and the irritation often produced on the sensitive dental pulps by their conductivity of thermal changes, frequently resulting in acute pulpitis and suppuration, has led within recent years to the extended use of porcelain fillings, either ground to fit the cavity or, what is better, fused in a platinum or gold matrix previously burnished and fitted to the tooth cavity. The great advantages of this material are apparent: (1) its non-conductivity; (2) the ease with which the colour of the tooth can be matched; (3) the strength and resistance it possesses. The cavity must be quite open, no undercuts, all the edges smooth and sharply outlined. A piece of very thin platinum foil is laid over it, and pressed into the cavity by means of amadou, or pieces of chamois skin, and a ball-shaped burnisher, till it fits accurately. It is then carefully lifted out without disturbing it, placed in a mixture of plaster of Paris and fine asbestos. When this material is hard, the cavity in platinum is built up by degrees with a paste of the porcelain chosen, and each layer melted, as added, in Mitchell's electric or other furnace, two or three minutes for each layer being all that is necessary for low-fusing porcelains, the higher fusing not having any great advantages over the low. When the matrix is full up to the edges and glazed, the inlay can be separated from the platinum, roughened somewhat with a diamond or other disc, and inserted into the tooth with a thin creamy cement of the proper shade. A series of matching shades are given with the material, so there is no difficulty about getting the right one. The author has frequently put porcelain

tips on fractured teeth, all of which have stood remarkably well, and when well made are scarcely detectable in the mouth.

Diseases of the Pulp

The pulp occupies the central portion of the crown of the tooth, and the root canal or canals, terminating at the apical foramen. It is largely endowed with nerves and blood-vessels, which terminate in loops, forming a fine plexus and network at the periphery of the organ. The pulp matrix is semi-gelatinous, and is thickly covered with cells, outer layer odontoblast, deeper layers oval, round, and connective tissue cells. Those cells, both in the bulbous and root portion, are more numerous at the periphery. In the root portion the long axis of the cells are parallel with the direction of the pulp canal. The anatomical relations of the pulp, and the fact that it is bound up in a rigid cavity, render it very susceptible to pathological conditions when irritated or inflamed. Pathological conditions of this organ might be classified thus :—

(1) Irritation of the pulp.
(2) Acute pulpitis.
(3) Chronic pulpitis.
(4) Abscess of pulp.
(5) Hypertrophy, atrophy, and degenerations of pulp.
(6) Secondary hard formations in pulp cavity.

(1) Irritation of the pulp is usually consequent on some slight injury to the enamel or subjacent dentine, either by caries, abrasion, erosion, or from fracture, or the conduction of thermal changes through a metallic filling and hypersensitive dentine. This sensitiveness to changes of temperature, it must be remembered, is one of the normal functions of the pulp. In such cases the irritation is conveyed to the pulp by means of the dentinal fibrils, as a result of which there is produced a certain amount of hyperæmia or determination of blood to the part opposite the lesion. This hyperæmia may only cause a slight distension of the blood-vessels, or result in extensive dilatation of the vessels without, however, any alteration of the tissue elements of the pulp. If the condition persists, or happens frequently, the vessels fail to contract owing to partial paralysis of their vaso-motor nerves and a permanent dilatation of their walls, results ending in exudation of their contents and the production of acute pulpitis. If, on the other hand, the irritation is removed by treatment, the pulp resumes its normal condition again. The pain caused by pulp irritation with hyperæmia is sharp, intermittent, and paroxysmal in its character, its location being commonly in the neighbourhood of the ear. The patient frequently has difficulty in locating the pain, or refers it to the wrong tooth. Pulp irritation may be, in certain cases, a resultant of pulp exposure, but in such cases the pulp speedily becomes acutely inflamed, and suppuration is likely to ensue.

Treatment.—The removal of any metallic filling, and dressing the cavity with a small piece of cotton-wool soaked in carbolised resin, or equal parts of clove and cinnamon oils, retained in place with a piece of guttapercha, or cotton-wool dipped in sandarach varnish. After the pulp has soothed down some non-conducting material should be inserted between the floor of the cavity and the metallic filling. Tincture of iodine applied to the gum is also useful in these cases.

(2) Acute pulpitis is pretty common as a sequence of long-continued irritation, but is much more frequent as a result of pulp exposure from caries, fracture, etc. The inflammation may be limited in extent, or may implicate the whole of the organ (Fig. 6). In the first instance, on examination of such a pulp, it will be found in the neighbourhood of the exposure of a bright red colour shading off from the periphery to the centre, the blood-vessels are numerous and distended with blood, the nerve bundles and connective tissue cells in neighbourhood of focus of inflammation present evidences of structural changes, while a molecular cloudiness may be noticed due to the presence of numerous fat globules. As the disease extends the normal elements of the pulp become to a larger extent replaced by inflammatory exudations and fat cells, and the distended vessels, especially at apex of root or roots, are liable to be strangulated, resulting in death of the pulp. Thrombosis of the main vessel may also lead to this result. A further pathological change may be suppuration (Fig. 8), wherein the exudation cells and tissue elements of the pulp proliferate extensively and become converted into pus cells, accompanying which condition there is usually

Acute pulpitis.

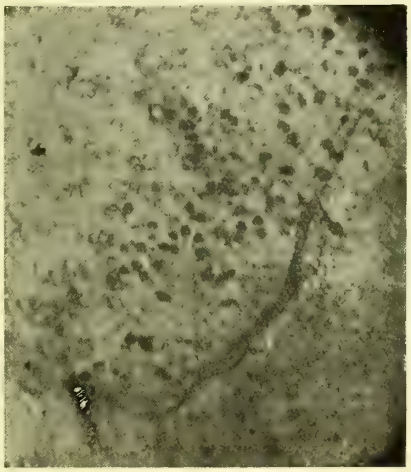


Fig. 6.

fatty degeneration. In acute pulpitis the odontoblast cells persist to the last, and are only destroyed when suppuration ensues. The



FIG. 7.

symptoms of total acute pulpitis are very severe. The inflammation extends to the peridental membrane, periosteum of jaw, and the affected tooth, and adjacent ones become loose and painful to touch. There may be also a certain amount of pyrexia present. In some very acute cases the colouring matter of the blood is forced into the tubules, producing a red staining of the tooth.

Treatment.—In cases of partial acute pulpitis the anodyne dressings already mentioned and counter-irritation to the gum may allay the inflammation, and enable the tooth to be filled. A non-conducting antiseptic formagen cement or guttapercha should be used to line the cavity with, the metallic filling being placed on the outside. In cases of slight exposure of pulp a hollow cap of vulcanite containing some antiseptic paste is carefully placed over the exposure, a little cement (oxyphosphate of zinc) over this, and remainder filled with amalgam or other suitable filling. In cases of total acute pulpitis, on the other hand, especially if the pulp is much exposed and the peridental membrane affected, it is better to destroy the pulp. This is usually done with arsenious acid, the physiological action of which is to produce embolism of blood-vessels of pulp. A small portion, about the size of a pin-head, of devitalising fibre (a vegetable fibre charged with As_2O_3 and creasote) is taken, and carefully inserted over the pulp, after having removed, with spoon excavators, as much as possible of the soft carious tissue from the cavity, and a piece of softened guttapercha is packed in to retain the fibre. As_2O_3, it must be remembered, is a very powerful escharotic, and must on no account touch the soft tissues of the mouth. In twenty-four hours or so the pulp will be found to be destroyed, and has to be thoroughly removed with fine barbed instruments, and the root or roots filled with guttapercha or cement, etc., under antiseptic precautions. To allay the pain incident to acute pulpitis doses of any of the following may be given:—Tincture aconite, tincture gelsemium, phenacetin, or a hypodermic injection of solution of eucaine may be useful.

(3) Chronic pulpitis, as a result of exposure, is met with more frequently than the acute form, and is very often overlooked by the patient, owing to the comparative immunity from pain associated with it (Fig. 9). Neuralgic pain in face, neck, or jaws is, however, a common association with chronic pulpitis. This form of disease is less amenable to treatment than even the acute pulpitis. The pulp at point of exposure, and for a slight depth beyond, is highly vascular and red, and from the surface is given off a serous or purulent fluid of a disagreeable phosphatic odour. Beyond the inflamed portion the pulp will be seen to be quite normal in its character. In the neighbourhood of the inflamed part the odontoblast cells are found atrophied and rapidly disappearing. As the ulcerative process extends, inflammatory degeneration is likely to ensue, and

Suppurating pulp.



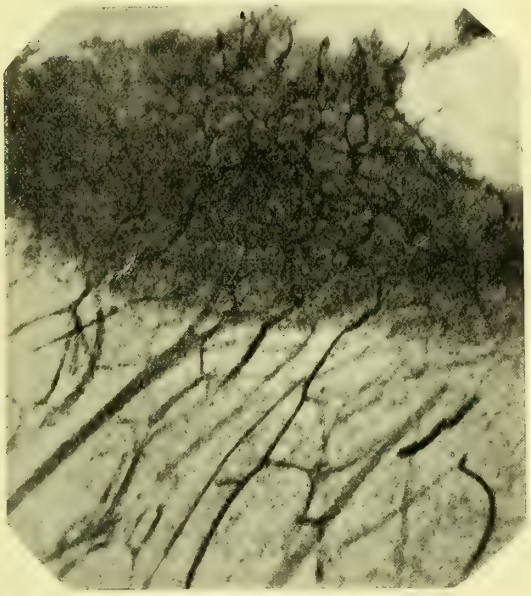
FIG. 8.

gradually reduces the pulp to a greyish yellow shrivelled mass, or, under favourable circumstances, the chronic may take on acute disease, ending in suppuration and gangrene. It is probable that the presence of micro-organisms

has something to do with the ulceration on the exposed surface of pulp.

Treatment.—The pulp should be destroyed and roots filled, using antiseptic precautions.

(4) Abscess of the pulp (Fig. 8) has already been mentioned as a sequence of acute or chronic pulpitis. Its occurrence is coincident with exposure of the pulp to the fluids of the mouth, which, it must be remembered, always contain pyogenic organisms. Professor Arkovy has pointed out the presence in all diseased pulps of an organism, the Bacillus gangrenæ pulpæ, which produces gangrene of this organ, and it also has a softening effect on the dentine. It may commence, as in chronic pulpitis, in a pus-secreting inflammation gradually invading the deep tissues of the pulp, having a tendency to penetrate in the direction of the main blood-vessels. In the neighbourhood of the focus of suppuration the blood-vessels will be found dilated into ampullæ, the odontoblast cells are gradually undermined and destroyed, while the nerve bundles become indistinct and speedily disappear. This destructive process may go on till the whole of the pulp is destroyed, or suppuration may stop short and fatty degeneration ensue. Another rare form of abscess of the pulp is described first by Dr. A. Hugenschmidt, of Paris, who called it partial suppurating pulpitis. It frequently occurs in a seemingly sound tooth. Such pulps, according to Dr. H., have on their coronal, or root surfaces, small ulcers which secrete pus, and which travel along the external surface of the pulp, and reach the apical foramen, forming a persistent abscess over apex of root. The author has met with one such case in practice. The peculiarity of this abscess is its association with a living pulp. The amount of pain present with abscess of pulp is proportionate to the amount of exposure of that organ. If there is little or no exposure the pain produced is very severe, as it cannot expand nor shed its purulent secretion.



Exposed and secreting surface of pulp.

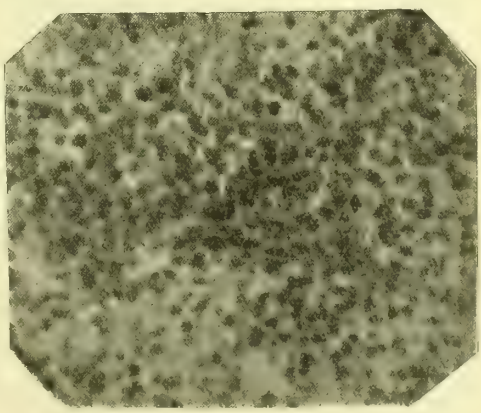
FIG. 9.—Chronic pulpitis.

Treatment. — Destroy pulp, cleanse canals thoroughly with antiseptics, and fill root canals, inserting a filling in cavity.

(5) *Hypertrophy, Atrophy, and Degeneration of Pulp.* — Hypertrophy of the pulp, as a result of chronic pulpitis, is of common occurrence (Fig. 10). It consists of an insensitive hypertrophic growth of the pulp, which bulges through the opening into the pulp chamber, proliferating, and filling up the carious cavity with a red fleshy mass. It is supposed to be caused by the irritation of the saliva, or from micro-organisms or their products. There is an entire absence of nerves which are atrophied, the blood-vessels being enormously dilated. Such growths are composed principally of multi-nucleated cells, analogous to granulation cells, with a greater or less amount of interstitial fibrous tissue. Such pulps never give rise to alveolar abscess nor cause odontalgia.

Treatment.—Application of nitric acid every two or three days, and the removal of pulp, roots filled, etc.

Degeneration of the pulp as a sequence of chronic inflammation and as a result of senescence is not uncommon, and might be divided into fatty degeneration, areolation, fibroid, and calcareous degeneration (Figs. 11, 12, 13). Fatty degeneration and other changes in the pulp generally take place as the result of subacute or chronic pulpitis, and are always an indication of diminished vital activity in the



The elements of pulp converted into cells analogous to granulation cells.

FIG. 10.—Degenerative condition of pulp. Hypertrophy.

organ. A pulp thus affected is reduced in volume, is somewhat opaque, and of a yellowish red or grey colour, and feels unctuous to the touch. As the process progresses the whole of

Fibrous tissue.

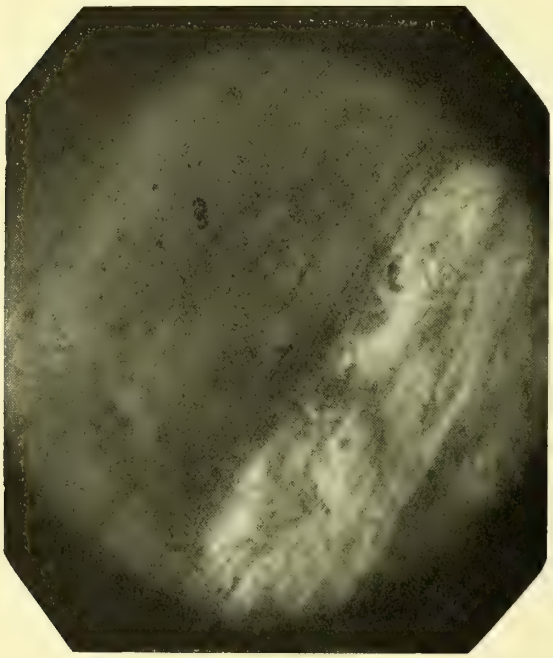


Fig. 11.—Fatty and fibroid pulp.

the tissues of the pulp become implicated. Scattered through the whole of the organ are numerous fat globules which obscure its ultimate structure. Such pulps do not give rise to abscess, or cause any trouble, unless exposed to the fluids of the mouth for some time. Areolation of the pulp is somewhat rare, and is a sequence of chronic pulpitis. The pulp is much reduced in size and resembles a thin membrane, is smooth in appearance, and red or brown in colour. Examined microscopically, it is found to consist of a reticulum of fine fibrous tissue, having scattered through the mesh-work of fibres numerous oval cavities. Part or whole of the pulp may be so affected. Wedl mentions another pathological condition seemingly somewhat analogous, namely sclerosis. Fibroid degeneration of the pulp, found chiefly in the worn-down teeth of elderly people, is a sequence of defective nutrition of the pulp (Fig. 12). There is an abnormal production of fibrous tissue, coarse or fine, occurring either in bundles or as a network, while the pulp cells, nerves, and blood-vessels atrophy, and if the process is unhindered the pulp shrivels up, becomes dead, or suppuration may attack and destroy it. Calcareous degeneration is very frequently associated with fibroid or fatty degenerative conditions of the pulp, and must not be confounded with calcified nodules, etc., in the pulp (Fig. 13). It consists of deposits of calcareous salts in the connective and other tissues of the pulp. The concretion is a product of inflammatory changes in the pulp, and is found in the shape of irregular, semi-transparent, oval, round, or cylindrical masses, very often adhering to the nerve-trunks or surrounding the blood-vessels, forming cylinders round them (Fig. 13). They present a rugose appearance, and are dissolved in dilute acid with the evolution of CO_2 gas; their chemical composition is supposed to be phosphate and carbonate of lime. As a rule this form of calcareous concretion is found more frequently in the radical portion of the pulp than in the bulbous part. This pathological degenerative condition of the pulp is of interest, since it frequently gives rise to very severe neuralgic pain, and that often in a tooth otherwise in very good condition. Its diagnosis is difficult, and if suspected the pulp should be destroyed, roots cleared out and filled, etc.

Fat cells.

(6) *Secondary Hard Formations in Pulp Cavity.*—Secondary hard formations might be divided into (i.) dentine of repair (adventitious dentine of Hopewell Smith), a new and somewhat regular growth of dentine adherent to the pulp chamber, and deposited opposite some lesion of the tooth, such as caries, abrasion, erosion; (ii.) dentinal tumour or odontome, an irregular oval, round, or stalactitic growth of dentine growing from the pulp chamber, the tubules of primary dentine being continuous

All the normal tissues of pulp have disappeared.



Fig. 12.—Degenerative condition of pulp. Fibrosis.

with those of the secondary growth; (iii.) osteodentine.

Included in this group are those irregular nodules of calcified tissue, with very small and erratic tubules, found scattered through the

tissues of the pulp. In form they are flattened, round, warty, or berry-like, and present no regularity in their histological structure, but sometimes they have a laminated concentric arrangement of their tissues round a portion of the uncalcified pulp. This somewhat corresponds to the structure of osteo-dentine, though lacunæ are absent. Osteo-dentine is a variety of dentine embracing the characters of both bone and dentine, and is, like other forms of secondary dentine, developed from the connective tissue of the pulp. It is found loose in the pulp tissues in the shape of round or irregular nodules. It usually contains a blood-vessel round which is developed a concentric arrangement of the tissues analogous to that of the Haversian system in bone, agreeing with this tissue in the presence of lacunæ and canaliculi. The pulp, when the subject of inflammation, expands like other tissues, and being forced against these growths, originates severe neuralgia. Any of those varieties of secondary formation may be the cause of neuralgic pain, but the variety that more especially is productive of this condition is (ii.) dentinal tumour or odontome. As this particular variety of growth occurs frequently in seemingly sound teeth, it is very difficult of diagnosis, but a skiagram taken of the teeth would show it up. The treatment would be to drill into the pulp, destroy and remove it, etc.

Diseases of Peridental Membrane

The peridental membrane covers the root of the tooth, and acts as a kind of cushion to the teeth when subjected to blows or roughly used in mastication. It is composed of fibrous tissue, is very vascular (the blood-vessels also supply the cementum with nutrition), and is richly supplied with nerves which are the source of the sense of touch in the teeth, and are the origin of the severe pain incident to conditions of inflammation of this organ.

Etiology.—The causes are various. General causes are gout, syphilis, rheumatism, struma, mercurialism. Local: blows, filling tooth too full, accumulations of tartar, phosphorous poisoning, putrid pulp, filling tooth before canals are aseptic. Strumous periodontitis is accompanied by less pain than that of the ordinary form of peridental inflammation, and suppuration speedily ensues. Rheumatic periodontitis, though rather painful, is of that kind termed plastic periodontitis, and does not tend to suppuration. Peridental disease may be divided into (*a*) acute; (*b*) chronic.

(*a*) *Acute Periodontitis.—Symptoms.*—Sensitiveness of root involved, characterised as a dull sensation of oppression in the tooth. After this has continued for some hours or days uninterrupted pain occurs in the tooth, and is intensified when the tooth is touched or used. Pain is also increased by warmth, active movement, the horizontal position, or stimulating drinks. The gum over the root of the tooth now becomes swollen, red, hot to the touch, sensitive to pressure, especially at apex of root, and the tooth feels raised in its socket. With some patients there is a general indisposition, furred tongue, and more or less pyrexia. The pain now becomes more severe, and the inflammation affects the tooth on either side, spreads to the gums and face, producing œdema. With the latter symptoms suppuration occurs, the pain becomes less acute, and assumes a more dull and pulsating character. Over the apex of root may now be observed a swelling which, on attaining its full size, becomes soft and fluctuating; the pus eventually forces its way through. As soon as the pus is evacuated there is a rapid diminution of all the symptoms, and the tooth after a time resumes its former position and firmness, or a chronic alveolar abscess may be formed. Average duration of acute periodontitis, seven or eight days. There are, of course, subacute forms of this disease also, which are more amenable to remedial treatment.



Fig. 13.—Calcareous degeneration of pulp.

Treatment.—In the acute form palliative treatment only can be used at first. The application to the gum of ℞ Tinct. iodine (lin.) ℥ij., acid carbolic ℥j., or capsicum plasters, freely incising the gum. Hypodermic injection into the gum of sol. eucaine, or the internal administration of 8 grains phenacetin every three hours; free purging. After the acute symptoms have disappeared thorough asepsis of root canal must be carried out, and the root and tooth filled. The diagnosis between acute pulpitis and acute periodontitis is not difficult. On tapping a tooth affected by acute pulpitis there will be little or no pain compared to that of the tooth with the inflamed peridental membrane. In the case of a front tooth there will also be some

discoloration due to staining of the dentine by the decomposing pulp.

(*b*) *Chronic Periodontitis.—Symptoms.*—These are very much less severe; in fact, at first they are of such an ill-defined nature that they easily escape the notice of less observant patients, until in course of time severe pain is felt at the apex of the root, intermitting, however, and the tooth elongates, or the gum becomes inflamed, and a yellowish mucous or purulent fluid of an offensive odour oozes out from between the gum and tooth on pressure being applied. Time after time the same thing happens, and the tooth is eventually lost from alveolar abscess. The process continues throughout a local one, and the general system is not disturbed. In chronic inflammation the peridental membrane gets very much thickened, and is often affected by degenerative conditions, fatty, calcareous, etc.

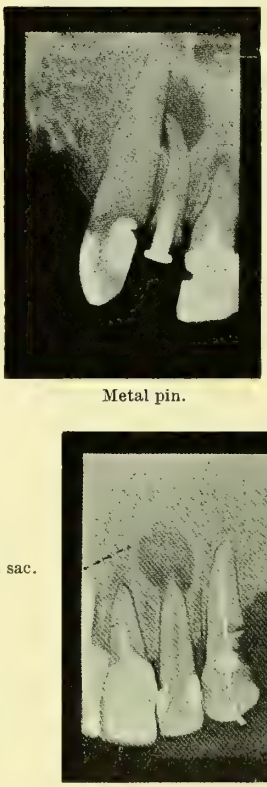
In teeth the subjects of chronic periodontitis there is liable to be produced exostosis, or absorption and redeposition may take place alternately.

General Periodontitis.—Several teeth may be affected by periodontitis, the inflammation spreading to periosteum of jaw and gums. This form occurs frequently as a result of typhoid, syphilis, necrosis, or the administration of Hg. or phosphorus. The symptoms are the same as those of the local form, and the treatment depends on the origin. To prevent suppuration free incisions of the gum are necessary, and the application of an astringent, such as tannin or phenate of soda, as a mouth-wash is useful. The majority of these cases are a result of septic conditions of the canals of tooth, which, therefore, should be attended to, and the gum also treated. Massage is useful. When the tooth is much elongated a portion of it or its opponent should be cut down. Dr. Kirk has recently drawn attention to cases of what he calls intra-peridental abscesses occurring in teeth with live pulps.

Alveolar Abscess

Periodontitis in connection with carious teeth leading to alveolar abscess is common to both jaws, or there may be developed an abscess in the substance of the maxilla or mandible. The symptoms of alveolar abscess are very similar to those of acute periodontitis—the tooth is loose, the pain severe, and of a dull throbbing character, the intensity of the pain at this stage being proportionate to the penetrability or impenetrability of the surrounding bone, which is removed by absorption produced by the abscess sac and its contents. The disease commences at the apex of the root of a carious pulpless tooth by the effusion of plastic material from the inflamed peridental membrane, which forms a sac at the extremity of the root, pus being formed in the interior. As the sac increases in size the surrounding osseous tissue is removed by absorption, and in some cases a considerable portion of the root may be destroyed by the same process.

Acute Alveolar Abscess.—The symptoms are very severe, and the consequent œdema more intense, the neighbouring teeth and alveolar periosteum being also affected by the extension of the inflammation. There are frequently febrile symptoms, quickened pulse, furred tongue, and general indisposition. As soon as pus forms rapid absorption of the surrounding bone takes place, and the pus finds an exit, either through the alveolus over the apex of the root, or it oozes out from between the gum and socket of the tooth. After evacuation of the pus the symptoms decrease rapidly, and the tooth regains its former state or assumes the chronic condition. The sac is sometimes brought away with the tooth on extraction. The sac of acute abscess is thin and smooth, in contradistinction to that of the chronic, which is very thick and rough, and sometimes contains calcareous matter or bony spicules. The extremity of the root in such teeth is sometimes surrounded by a deposit of tartar derived from the exuded blood or serum.



Skiagram illustrating abscess formation in relation to teeth and proximity to nasal fossa.

Chronic Alveolar Abscess.—The symptoms are slight and local. There is generally a discharge of pus, more or less constant, through

a sinus at or near the apex of root of abscessed tooth. Pus from an alveolar abscess may travel a great distance from its source, always taking the easiest route. The usual position for the pus to make an exit is through the external alveolar plate near apex of root. Alveolar abscess in connection with upper incisors has been known to point in the nostril. Tomes and others have drawn attention to this peculiarity of the maxillary lateral incisor, the pus from which has a tendency to burrow beneath the periosteum and bone of hard palate, and opening on the soft palate, forcing the soft tissues down to the level of the teeth. But pus may find its way on to the face, beneath the chin, or into the antrum. In the case of the third molars pus frequently passes between the muscles and the bone, and escapes at the angle of the mandible, the nape of the neck, or even on the thorax. There are also cases of chronic abscess without a sinus, which are much more difficult of treatment. Abscess of teeth in the mandible, as in the maxilla, more frequently points through the external alveolar wall than through the lingual. An abscess sometimes forms in the substance of the maxilla or mandible as a consequence of the presence of diseased teeth, but differs from ordinary alveolar abscess in that it does not discharge through the tooth-socket, but causes considerable expansion of the bone and consequent disfigurement, especially in the mandible. In the maxilla it has been mistaken for antrum disease. Sequelæ of alveolar abscess: sub-periosteal effusion, producing necrosis of bone; suppuration of adjacent lymphatic glands; pyæmia, œdema, and spasm of glottis; cellulitis; postpharyngeal abscess; paralysis of facial muscles; trismus; paralysis of arm.[1]

Treatment.—Acute.—In cases where pus is oozing from between the gum and socket of the tooth it is better to remove it at once. If the tooth is savable palliative remedies should be applied, the pus evacuated by free incisions, tinct. iodine lin. applied to gum, or by electrical cataphoresis, capsicum plasters, etc.; half gr. pil. calci sulph. every three hours are useful to cause absorption of inflammatory exudate. After acute symptoms have disappeared the canals should be made aseptic and filled, also tooth cavity. In chronic alveolar abscess the root canals should be cleansed, and H_2O_2 forced through the tooth and sinus by means of an abscess-syringe, etc., finishing up with pure carbolic acid, tincture of iodine, or alcoholic solution of hydronaphthol, the tooth temporarily dressed, and this treatment repeated every three or four days till all tenderness over root has disappeared. Immediate root-filling is practised by some, but cannot be depended on. In teeth with no sinus repeated cleansing of the root usually results in the abscess healing up, but it is necessary in some cases to drill a hole over apex of tooth, so that some antiseptic may be forced through, or the abscess-sac destroyed and the root and tooth filled. In cases of abscess in the substance of the bone, the tooth causing the condition should be removed, and the abscess cavity scraped and packed with boric lint till healing takes place. Excision of the whole or apical portion of the root of an abscessed tooth is sometimes practised for the cure of chronic alveolar abscess.

[1] Article "Teeth," by G. W. Watson, L.D.S. See p. 537.

Exostosis

The cementum which forms the outer layer of root of tooth is very liable to hypertrophy, which is induced by chronic irritation of the peridental membrane. Normally, the amount of this tissue on healthy teeth varies greatly, so much so, that it is difficult in slight cases of exostosis to diagnose between normal and abnormal conditions. The usual form of exostosis consists of an excess of the normal tissue, layer after layer of the tissue being deposited on part or whole of the root (Fig. 14). It is usually non-vascular, but sometimes blood-vessels penetrate into it, the tissue forming a kind of Haversian system round it. Any part of the root may be affected by exostosis, but its usual situation is on the lower third of root of the tooth. The varieties are—(1) a globular, encircling the extremity of the root; (2) an irregular mass encircling extremity of root or roots, or whole of the root; (3) an even incrustation of whole root, becoming attenuated towards the neck of tooth; (4) as small isolated nodules, very hard and attached to the side or near the extremity of root. When from alveolar abscess the whole or a portion of the peridental membrane is destroyed, no development of cementum can take place, which accounts for

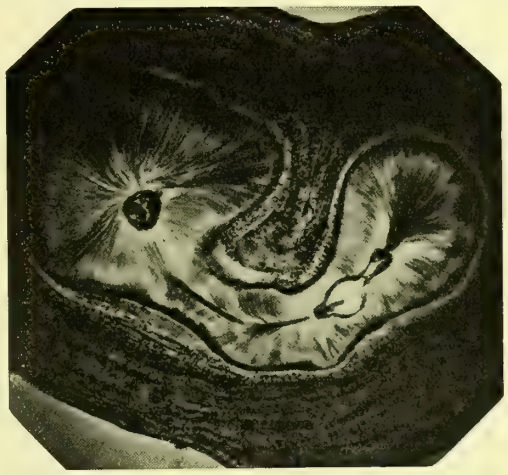


FIG. 14.—T. section of M♀ affected by exostosis.

those cases where the exostosis recurs on one side of root only or in patches. In well-marked cases of the disease distinct laminations are observed, lacunæ and canaliculæ being scattered through them, intercommunicating with each other (Fig. 14). Two or three teeth or roots are occasionally found united together by cementum.

Symptoms.—When the disease has its origin in a tooth also affected by caries, it is extremely difficult to diagnose, owing to the similarity of the symptoms to other pathological conditions, such as chronic pulpitis, etc., and this is much more the case when the crown of the tooth is free from any lesion. Neuralgic pain in face, head, or neck may be, and often is, the only indication of disease, making it very difficult to diagnose which tooth is at fault; and it is only after prolonged suffering that a diagnosis can be made, the tooth becoming painful on tapping, or to thermal changes. A ready method of diagnosing exostosis can be effected by taking a skiagram of the teeth on the side affected. In some cases tooth after tooth has to be sacrificed on account of this disease. The variety of exostosis which is productive of the most agonising pain is the isolated nodule, which fortunately is somewhat rarer than most of the other forms. The severe pain incident to this condition is produced by the pressure of those irregular growths on the irritated nerves of the peridental membrane.

Treatment.—Extraction.

Pyorrhœa Alveolaris

Pyorrhœa is a disease which has been prevalent among mankind and also some of our domesticated pets from the earliest times. The local conditions to which the name pyorrhœa has been applied consist in a deeply congested condition of the mucous membrane round the necks of the affected teeth, to which it is non-adherent, accompanied by a thick, fœtid, purulent, or sanious discharge, laden with micro-organisms, exuding down between the gum and the tooth on pressure being applied, and which communicates a most offensive odour to the breath. After a time the alveoli become absorbed, and the peridental membrane of the root is gradually destroyed, accompanied by loosening of the tooth, exposure of part of the root, and a deposit thereon of salivary calculus of a greenish brown colour—though this is not invariably the case. In some conditions of this disease there is no recession of the gum, and little or no tartar present. One tooth only, or several, may be attacked at a time, and the front teeth are more prone to this disease than the posterior. The disease may be acute or chronic, and generally occurs in patients of middle age, and who are in a debilitated condition, suffering from some chronic disorder, such as gout, syphilis, Bright's disease, anæmia, tuberculosis, etc. Or the cause may be local, such as oral uncleanliness, the presence of tartar, or badly adapted artificial plates or crowns. The disease in its earlier stages is quite curable, but if allowed to progress till the tooth socket has been destroyed little good can be done. The extraction of affected teeth stops short the disease, and it is of interest to note that the destruction of the pulp likewise has this effect. Medical opinion in recent years, in reference to pyorrhœa, seems to bear out the idea that this disease is a frequent source, when neglected, of various diseased conditions in the lungs, bronchial tubes, pharynx, pericardium, etc. (Spencer, Savill, Ewart, Godlee, etc.). There is no doubt that very septic conditions frequently prevail in pyorrhœa cases, making it a source of danger.

There are differences of opinion as to whether the disease is due to local or constitutional causes.

Treatment.—The Americans, attributing this disease largely to the presence in the blood of uric acid, treat it accordingly; but there is no warrant for this belief, or that it should be produced by this diathesis, more than that of any of the other conditions predisposing to it already mentioned. Local treatment consists of syringing out the gum sockets with 3 per cent H_2O_2 or pyrozone, then follow up with a drop or two of pure carbolic acid, or with a flattened piece of wood pack the pockets with powdered sulphate of copper. The latter treatment should be repeated every four or five days, and generally in a few weeks results in a marked improvement of the symptoms. All loose teeth should be removed, and also any tartar covering the root, special instruments having to be used for this purpose. Another very valuable adjunct in the treatment of this troublesome disease is electricity applied by means of zinc or copper electrodes applied to the gum pockets in the presence of dilute acid, the beneficial effect of the acid salts so generated being obtained on the diseased tissues.

Irregularity in Number, Size, and Position of the Teeth. Deficiency of Teeth.—The tooth, perhaps, most frequently absent from the series is the maxillary lateral incisor; one or both may be absent, and this is very often an hereditary peculiarity. Absence of teeth, however, does not always mean their entire suppression, as they frequently are deeply buried in the substance of the jaw, and only turn up after all the other teeth are lost. The most of the so-called cases of third dentitions are just analogous cases. The author has models of two cases where in edentulous subjects, one aged eighty-six, the other seventy-eight, two canines appeared. Cases have been recorded of the entire absence of both temporary and permanent dentitions, or of the presence of only a few teeth in either jaw. Supernumerary teeth might be divided into—(1) teeth resembling the normal

members of the series—centrals, laterals, canines, and bicuspids; (2) conical teeth, having no peculiar characteristics. The first are sometimes called supplemental teeth, and are found generally in the front of the mouth, either in line with the other teeth outside the arch, or on the palatine side of incisors. In the mandible they are placed on the lingual side of the incisors. These supplemental incisors are thought to be just a reversion to the typical number. Extra canines, and three bicuspids on either side, are fairly common; an extra molar on either side has also been observed. Supernumerary teeth are conical in shape, with a short single root. They are usually found present in the incisor region, between or at the back of them, and sometimes in association with the third molar, especially in the maxilla.

Treatment.—If ranged alongside of the other teeth, and the patient is over twenty years of age, it is better to retain them; if, on the other hand, the patient is young, it is better to extract. Teeth situated on the palate, or outside of the arch, interfering with the tongue or bite, are better removed. Teeth excessive in size, amounting almost to deformity, are met with sometimes, and are frequently an association of hyperostosis.

Irregularities in the position of individual teeth, and abnormalities of the maxilla and mandible, are very common in the present day, and seem to be to a certain extent more prevalent among civilised than among savage races. A great many causes are adduced to account for it; the disuse of one's jaws and teeth, owing to the prevalence of cooking, the early loss or extraction of the primary teeth, or too long retention of them, all influencing more or less vicious arrangements of these organs; while malformations of the maxilla and mandible may be caused by thumb or tongue sucking, mouth breathing, the presence of adenoids, etc., or may be congenital

In treating cases of irregularity it is important to know which teeth to extract and which to retain, so as to make room in the arches. As a general rule, with young patients, say from ten to fourteen, the first molars, especially if carious, should be extracted, this being a tooth that almost invariably, sooner or later, is attacked by this disease. In patients from fourteen to eighteen years of age it is better practice to extract the first bicuspid, as the teeth will be more readily and quickly acted on by regulating apparatus. In the case of the incisors, it may be necessary sometimes to extract the laterals; but of course both ought to be removed, as it would make the arch unsymmetrical if only one were extracted. The prominent canine teeth should always be retained, as they are characteristic feature teeth, unless they lie in such a position as to make it impossible to get them into place in the arch. The temporary canines should also be retained as long as possible, because their successors do not erupt till after the tooth on either side is in place, and are liable to be crowded out if the space is not kept.

Another important matter is, not to commence at too early an age to treat mechanically such conditions, and also to remember that, provided there is room, the lips and tongue, aided by some help from an intelligent patient, work wonders in bringing into place teeth very badly misplaced.

A good method of finding out, before treatment, what room will be obtained in the arch, and how the teeth will look, is shown by taking models of both jaws, cutting off from plaster cast the teeth proposed to be extracted, also all the irregular teeth, and refixing them with wax in their normal positions, so as to articulate with the bite. This enables you at once to see how they will look, and what room you have to come and go upon.

Irregularities of the Separate Teeth.—Maxillary central incisors may bite inside, instead of outside, of the mandibular teeth. A vulcanite plate covering the molars, so as to raise the bite, and compressed hickory wedges, or piano-wire springs, fixed at the back of the misplaced teeth, will speedily remedy this defect. Protrusion of these teeth is common, and necessitates the extraction of a tooth on either side, and the application of pressure from the front by means of elastic bands, or what is better, piano or gold wire, adapted to the outer surfaces of the teeth, and attached to metal bands round the posterior teeth, and capable of being tightened. The two teeth are sometimes overlapped, or are arranged at right angles to each other, in which case the operation of torsion may be employed. Forceps are carefully padded, and the tooth or teeth are carefully twisted into position, being retained there with a splint till fixed.

Lateral Incisors.—Irregularities in these teeth are common outside or inside of bite, or twisted on their axes to various degrees. Some operators practise alveolotomy in bad cases of irregularity, which consists in making incisions with a saw through the alveolus on either side of the tooth to be moved, and forcing the tooth with suitable forceps into its proper position, retaining it there with a plate.

Canines frequently erupt considerably outside of the arch, both generally being affected, and there may be no room for them in the arch. To remedy this in young patients the first molars should be extracted, and the bicuspids retracted by means of a spring plate, etc. The extraction of the first bicuspid in older patients produces more certain and more rapid results. Canines sometimes erupt on the palate, in which case extraction is the only remedy. Bicuspids or molars, if crowded out of the arch, are better

removed. The third molar assumes various irregular positions: its crown may be projected against the root of the second molar, and cause caries or absorption of it, or it may incline backwards, outwards, or inwards.

Abnormalities of the Jaws and Teeth. 1. **V**-*shaped Maxilla.*—In this deformity the arch is very much narrowed by the approximation of the bicuspids towards the middle line. In some cases the two centrals meet at an acute angle and project very much. The condition is frequently an hereditary one, though in some cases the presence of adenoids or enlarged tonsils may aid indirectly in producing this deformity. Some authorities have also asserted that congenital idiocy is frequently associated with it.

Treatment.—If an inherited condition, treatment is very often unsatisfactory, as the teeth have a tendency to return to their original positions. The usual method is to make a split vulcanite plate, on which is fixed a jack-screw capable of being tightened up, and acting on the alveolus and teeth on either side in the neighbourhood of the bicuspids. Or a split plate with piano-wire spring may be employed.

Underhung Bite.—In this irregularity the four or six front teeth of the maxilla bite at the back of those of the mandible, giving the mandible a very prominent appearance. To correct this irregularity the bite is raised by capping the posterior teeth, and the teeth affected are forced outwards gradually by means of screws, piano-wire springs, or hickory wedges, till they overlap the lower teeth, when the plate can be removed.

Open Bite.—This is a very disfiguring deformity, in which the upper and lower teeth are separated from one another by a wide space, the only teeth touching being the bicuspids or molars. A large number of those cases are due to thumb or finger sucking, which is sometimes continued well into adult life. The alveolar process of maxilla and teeth are gradually forced upwards and outwards by the persistent pressure, and the mandibular teeth are forced downwards and outwards from the same cause. Other causes are tongue-sucking, the persistent use of artificial teats, arrest in development of the anterior segments of the maxilla, or defective development of the ascending ramus of the mandible.

Treatment consists in grinding down the antagonising teeth so as to allow the jaws to approximate, or the extraction of the first molar teeth, and the use of a chin and skull cap for six or eight months may lead to some improvement.

Dental Necrosis

A pulpless tooth still has a certain amount of vitality through the nerves and blood-vessels of peridental membrane which supply the cementum and probably a layer of the dentine also. Partial necrosis is the proper term to apply to such a tooth. When the peridental membrane as well as the pulp is destroyed (complete necrosis), the tooth becomes loose, and is speedily cast out as a foreign body. Partially necrosed teeth last wonderfully well, but are more prone to caries owing to the loss of vitality. One root of a multiple-rooted tooth may become necrosed, and is liable to be very troublesome. Heat and cold affect it, likewise pressure, the cause of the latter being the irritation produced on the soft tissues at root apex by the roughness or sharpness of root caused by absorption. Discoloration of necrosed teeth is common. A pinkish or dark grey hue is commonly produced. Necrosed teeth sometimes cause severe inflammation and necrosis of a portion of alveolus.

Treatment.—In partial necrosis of a multi-rooted tooth, amputation of affected root is recommended, or extraction of tooth. When the crown of any of the anterior teeth is discoloured as a result of caries and partial necrosis, it is advisable to bleach it. The carious tissue is removed, the pulp canal antiseptically treated and filled. The cavity should then be wiped out with absolute alcohol, and hot air applied, then washed out with dilute ammonia, dried with hot air, and a piece of cotton-wool saturated with H_2O_2 or pyrozone inserted, and hot air applied to this. This treatment, applied every three days or so, three or four times, has a wonderful effect in restoring the colour of badly discoloured teeth. Electric cataphoresis with pyrozone is, however, more speedy in its action than the above. In cases of total necrosis it is better to remove the tooth at once.

Abrasion and Erosion

In certain conditions of the bite, notably that of edge to edge, the teeth get rapidly worn down till near the gum margin, leaving a smooth and polished surface. As the process advances the pulp is encroached upon, and frequently the teeth get very painful, though more commonly the pulp calcifies in advance of the wear. In countries where little pains are taken in preparing their flour, which consequently contains sand, the teeth are rapidly worn down from this cause till there is nothing left but roots.

Erosion may be described as a gradual destruction of the labial portion of a tooth, occurring as a transverse, smooth, open groove at the neck of the tooth, more especially of the incisors, canines, and premolars, and gradually progressing till the tooth is broken across. Erosion is a condition little understood, though recognised by some of the old writers—Fox, Hunter, etc.—many years ago. Various theories have been adduced to account for it. It has been attributed to friction of the lips, excessive

use of tooth-brush and powders, gout, acids, etc. From microscopic investigation, Mr. Underwood has found that teeth affected by erosion are structurally defective, more especially the enamel, and all authors agree that the oral secretion in all such cases is strongly acid. Drs. Kirk and Buchard were the first to suggest that the irritated labial follicles in the mucous membrane opposite the affected teeth might be the cause of the erosion. Mr. Royston, in a paper on erosion published recently, gives a valuable hint in reference to the treatment of such cases, suggesting that not only the tooth, but also the mucous glands in neighbourhood of teeth affected, should be touched with $AgNO_3$, he having found great benefit resulting therefrom.

Treatment.—Abrasion.—When the teeth are much worn down, caps of gold or porcelain tips are fitted to the teeth. When there is tenderness of tooth the application of $AgNO_3$ is useful. Erosion.—$AgNO_3$ applied to surface of teeth affected, and also to mucous glands contiguous to teeth; also the daily use of Phillips' milk of magnesia as a mouth-wash will be found of great service.

Electro-Cataphoresis

Within recent years cataphoresis has been extensively used for various dental operations. It may be described as electrical diffusion of fluids through the soft and hard tissues, a kind of electric osmosis. A series of dry-cell batteries, capable of producing a current up to about forty volts or so, is used, and an instrument, rheostat or volt selector, also a milliampèremeter, to record the quantity administered. Various electrodes adapted for the different purposes are used. In the destruction of a tooth pulp the positive electrode is applied to the tooth, the negative—attached to a wet sponge—held in the hand; a piece of cotton-wool saturated with a 20 per cent solution of cocaine hydrochlorate in guaiacol, or meditrina, is inserted into the cavity of the tooth, and the current gradually turned on. One-twentieth of 1 milliampère to 3 or 4 milliampères is all that is required for dental operations, but the time taken is rather a serious consideration, seven minutes to fifty or sixty minutes being commonly required to get the requisite results. Sensitive dentine can be obtunded by this means, and the pain of acute periodontitis allayed by it, while discoloured teeth are readily bleached by the aid of a 20 per cent solution of hydrogen peroxide. For tooth extraction it is not so successful.

Oral Sepsis and General Bacteriology of Mouth

As is well known, the oral cavity forms a very suitable incubator for the various micro-organisms. The number of organisms present in any mouth is proportionate to the cleanliness with which it is kept, and the condition of health or disease of the contained organs. When teeth are defective in number and the mouth full of diseased and putrid roots, there will be also present, as a result of such conditions, numberless pathogenic and non-pathogenic bacteria, and, as a sequence of such an insanitary state of the oral cavity, the patient is likely to suffer from some of the following: dyspepsia, anæmia, headache, constipation, etc.

About 1882-84 Professor Miller of Berlin began publishing a series of papers in reference to the organisms of the mouth and their connection with disease, which greatly extended our knowledge of the important bearing micro-organisms have in the production of various diseased conditions in the oral cavity and at a distance. The human mouth is well adapted for the development of bacteria; the constant temperature and the presence in the mouth of food debris, dead tissues, etc., all conduce to the nutrition and rapid proliferation of micro-organisms. Almost every known variety has been found in the human mouth, and in certain diseased conditions, such as that of typhoid, there may be present animal organisms also. Virulent pathogenic bacteria are frequently found even in healthy mouths. The danger of infection from the presence of such pathogenic organisms is proportional to the dosage, the condition of the mucous membrane, and the immunity or non-immunity of the individual when subjected to infection. In the dirty and diseased mouth are found at the margins of the gums, on and between the teeth, masses of micro-organisms, streptococci, staphylococci, bacilli spirillum sputugenum, spirochæta dentum, yeast cells, etc. (Fig. 15). The removal of septic roots and proper cleansing of the mouth have a wonderful effect in reducing the number of microbes, especially the coma and spirillum forms, which are always present in large numbers in diseased and filthy conditions of the oral cavity.

Of twenty-two microbes isolated by Dr. Miller, ten were in the form of cocci of various sizes, five appeared as short, and six as long staffs. One species formed spirilla, another developed long threads. Of thirty varieties cultivated subsequently eighteen were cocci, eleven staffs, one formed threads in fluids, three developed long connected or unconnected threads, one produced spirilla, eight were motile, fourteen immotile, only three showed spore formation, the others seemingly propagating themselves by fusion. They exhibited great differences in their relation to oxygen; ten were found aerobic; four grew best in air, but could also do without; eight proved to be chromogenic, producing yellow masses in nutrient jelly. Dr. Miller also pointed out that the pigmentation of the dentine in dental caries is due to pigment-forming bacteria; various

shades of black and brown are the usual colours produced; and he separated by cultivation twelve organisms which developed lactic acid in the mouth, and states that a great many of the oral microbes are capable of generating acid from cane or grape sugar, and that it is probable that all of them, under favourable circumstances, are capable of so doing. According to Arkovy, one of the organisms most frequently found in dental caries and in the pulp is bacillus gangrenæ pulpæ. Its relative frequency compared with other organisms is 95·3 per cent; the next most frequent, staphylococcus pyogenes aureus, 23·2 per cent; streptococcus citreus, 4·6 per cent; bacillus pyocyaneus, 9·3 per cent; and some nine other organisms, mostly harmless. Bacillus gangrenæ pulpæ is a pleomorphous organism, forming bacilli when

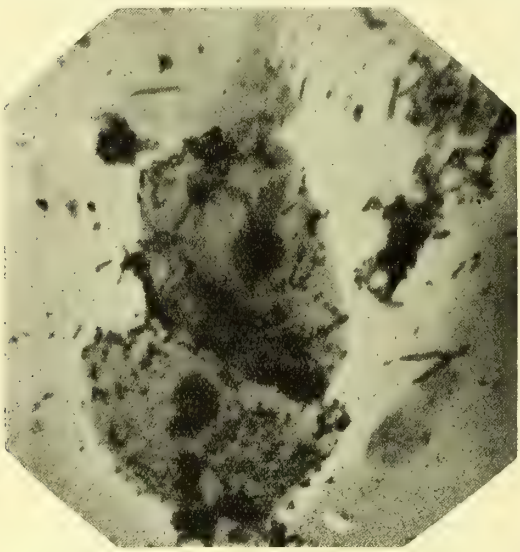


FIG. 15.—Two epithelial scales from mouth covered with micro-organisms.

grown on nutrient jelly, and cocci when grown on agar agar. Pure cultures of this microbe have the specific effect of producing gangrene of the dental pulp. This microbe also has the power of softening dentine, and forms a brown pigment in the hot incubator. The presence in the mouth of such large numbers of micro-organisms, many of them pathogenic, suggests the possibility of infection, and that this frequently occurs in the septic mouth full of diseased and abscessed teeth no one can doubt (Fig. 15).

Infection may be induced—

1. As a result of abrasions, wounds, ulcerations, etc., of the mucous membrane of the oral cavity.

2. Through exposure, ulceration, or suppuration of the dental pulp, leading to apical abscess, and eventually to fatal septic poisoning.

3. From absorption of bacterial products, ptomaines, etc.—local.

4. From swallowing bacteria or their poisonous products, inducing gastric, intestinal, or other disorders.

5. From debilitated and diseased conditions of mucous membranes, making them more susceptible to infection.

Professor Miller, and more recently Dr. Hunter, have shown that locally such diseased conditions as necrosis, cellulitis, meningitis, ostitis, periostitis, and pericarditis may have their origin as a result of organismal oral infection, while the stomach and intestinal tract, owing to the numerous microbes and their products swallowed, are liable to be affected by gastric or intestinal disorders. No doubt large numbers of the microbes swallowed are destroyed by the free HCl, but if this state of infection continue for any length of time, the resistance is lessened, or absolutely lost, and conditions of disease are induced. Professor Miller demonstrated that mice and other animals inoculated with saliva (mixed infection) invariably died in from twelve to thirty-six hours. He also tried experiments of pure cultures of four organisms obtained from diseased mouths—

1. *Micrococcus gingivæ pyogenes.*—Injection under the skin of mice produced abscess, necrosis of skin, and generally death. Abdominal injections caused death in from twelve to twenty-four hours.

2. *Bacterium gingivæ pyogenes.*— Abdominal injections. Death in from ten to twenty-four hours. Subcutaneous injections resulted in the formation of extensive abscesses.

3. *Bacillus dentalis viridans.*—Abdominal injections. Death in from twenty-two hours to six days from peritonitis.

4. *Bacillus pulpæ pyogenes* injected into abdomen proved fatal in from eighteen to thirty-six hours.

Tuberculous suppuration in the lymphatic glands of the neck frequently originates as a consequence of the presence in the mandible of diseased and abscessed teeth.

Odenthal examined 987 children, and found carious teeth in 429, in 558 no caries. Of the 558 without caries, glandular swellings were found in 524, or 99 per cent. Hugo Stack (1896) examined 113 children with glandular swellings of neck. In 41 per cent he found carious teeth, and in all of them the situation of the glands corresponded to the affected teeth. In three children with tubercular glands in the neck he also found carious teeth, but could not detect tubercle bacilli in these. In a girl of fourteen years of age, otherwise healthy, he detected a mandibular molar containing tuberculous granulation tissue, and on the side tuberculous glands, while there were none on the other. In a paper read before the Odonto-Chirurgical Society in 1889, the author made the suggestion that tuberculous infection of the lymphatic glands in the neck might originate

as a consequence of infection from a diseased tooth, or an abrasion or wound on the mucous surface—a carious tooth with an exposed and inflamed pulp forming a good nidus for the development of tubercle bacillus, which, being taken up by the blood-vessels of the pulp and deposited in the nearest lymphatic gland, originates the tuberculous condition. This is generally accepted as a fact in the present day. Tubercle bacilli, pyogenic and other bacteria, are frequently found in the tonsils, experiment having proved that tonsillar tissue when injected into animals gives rise to tuberculosis in about 13 per cent of cases (Dieulafoy). The organism associated with thrush, oidium albicans, is often found in the throat or tonsils of tuberculous patients. The disease called pyorrhœa alveolaris, in which septic conditions are frequently present, is a fertile source of infection in many patients.

Other organisms frequently found in the oral cavity are pneumococci, which may under favourable conditions produce various lesions of the lungs, such as croupous pneumonia, etc. The occurrence of diphtheria bacilli in the healthy human mouth is quite common (Löffler). Recent investigators state that diphtheria bacilli persist in the mouths and noses of patients long after convalescence from the disease. Syphilis: the majority of the cases of infection from this disease have their origin in the oral cavity, being transmitted by the saliva; wounds, dirty instruments in transplantation of teeth, or the use of other people's infected tooth-brushes or pipes, are all frequent sources of conveyance. Actinomycosis very frequently attacks the human subject, infection being conveyed through wounds or abrasions of the mucous membrane, or proliferation takes place in the exposed canals of some diseased tooth. The usual symptoms are numerous abscesses appearing in the neighbourhood of the infected part, discharging profuse stinking pus of a yellowish colour, containing small granules—portions of the ray fungus. 113 cases of actinomycosis in the human subject have been recorded by various authors. In 53 cases out of this number the disease originated in the oral cavity, on the cheek, tongue, jaws, or neck.

Treatment.—In the treatment of oral sepsis all diseased roots and teeth should be removed (the reprehensible practice of some practitioners of cutting over the six front teeth, and without filling and treating the roots, cannot be too strongly condemned), and the patient's health built up with tonics, and light and easily digested food given, while an antiseptic mouth-wash should be frequently used. A teaspoonful of alcoholic solution of hydronaphthol in water or phenate of soda may be employed, previous to the use of which, however, a 3 per cent solution of H_2O_2 in water should be employed, the frothing of which helps to remove the debris of food on and between the teeth, and enables the stronger antiseptic to have more effect. An astringent mouth-wash can be used later on: ℞ Tannin ʒj., tinct. iodine ʒss., tinct. pyrethri ʒj., spirit. vin. rect. ℥iss., aqua rosæ ℥vij. Of course, if the teeth are too few to properly masticate with, artificial substitutes should be provided.

Mills and Underwood, at the International Medical Congress, London, 1881, presented a communication on dental caries, stating that micro-organisms were always present in dental caries, and were the cause of distension of the tubules, and that two factors were always in operation—(1) the action of acid; (2) the action of germs,—which views were a great advance in the right direction. Shortly after this date Professor Miller, Berlin, began his investigations in regard to the microbes of dental caries and of the mouth generally, and great credit is due him as being the first to demonstrate the true pathology of dental caries. He also succeeded in producing artificial caries in sound teeth by placing them in a mixture of starch and saliva, the starch having been previously sterilised. This mixture was kept at a constant temperature in the incubator, and became acid in from four to five hours. In the course of two or three weeks the teeth were found softened, and presented all the appearances of natural caries—the tubules broken up and distended with micro-organisms. Cultures made from the artificially produced carious tissue developed organisms which Miller thought identical in form with those of bacillus acidi lactici, and by an elaborate chemical experiment demonstrated the correctness of this view. He also produced artificial dental caries by means of a pure culture of a pleomorphous organism obtained from the mouth.

The exposed portion of the crown of a tooth is covered by enamel, principally made up of lime salts; any defect in its structure is liable to be attacked by the acids generated by the numerous bacteria which find lodgment on and between the teeth, and which, on reaching the dentine, penetrate the tubules rapidly in the direction of the pulp, softening and breaking up the tissues in their progress. Briefly, then, in the process of dental caries there is (1) decalcification of the hard tissues of the tooth by lactic acid generated by microbes; (2) peptonisation and assimilation of the animal matter of the dentine, accompanied by alkaline products. Dr. Miller pointed out that micro-organisms grown in different culture materials had a modifying effect on their products; thus proteids caused decomposition, with alkaline products, hydrocarbons had little or no effect, carbohydrates developed acid. Structural defects both of enamel and dentine predispose to attacks of caries, although, according to Black, etc., the hardness or softness of a tooth has nothing to

do with its predisposition to caries. Leptothrix forms are very common in the oral cavity, and generally considered to be just transition forms of pleomorphous organisms.

In 1888-95 Dr. Vincentini of Italy made a most interesting and valuable discovery in connection with the organisms associated with caries, and figured and described an organism of a higher type than usually obtains in the mouth, which he says is invariably found in great abundance adhering to the teeth in gelatinous plaques, and which he named leptothrix racemosa. He asserts that this is the parent organism of most of the bacteria of the mouth, and it certainly looks as if there was some truth in this, as preparations made from scrapings of teeth exhibit all the different varieties usually found in the mouth as well as the characteristic peculiarities of L. racemosa. Vincentini showed chromo drawings of this organism, and represented it as exhibiting four different stages, and that the highest of which was an arrangement of spores round a central stem forming club-shaped masses, and that the organism which produced these spores was the parent form of the whole, or nearly the whole, forms of microbes of the mouth; leptothrix filaments, so common in the mouth, being just portions of the stems. He described the parent organism as being composed of fertile filaments or stems, containing in their interior gemmules, and attached round their stems by very fine threads were a series of spores in six or more longitudinal series. Little or no attention was paid to this important communication for some years, till Mr. Mummery and Professor Miller took it up, and were able to make out with certainty the club-shaped bodies, etc., described. Later on Dr. J. Leon Williams worked at the subject, and was able to show by means of a series of beautiful microphotographs the various forms assumed by this organism, and established beyond doubt that this is a new and hitherto undiscovered micro-organism. It is most remarkable that this microbe has so long been overlooked by bacteriologists. Dr. Williams suggests that this was probably due to the fact that it can only be demonstrated by special methods of staining and mounting, for if mounted in balsam it does not show up at all. Dr. L. Williams' method in the preparation of specimens is as follows:—

Wash with a stream of sterilised water the surfaces between two teeth, and with a small sterilised knife scrape the surfaces; the pasty-looking mass so obtained is placed in a clean watch-glass and covered with 20 or 30 drops of a rather watery solution of methyl violet in aniline water for twelve hours, occasionally teasing it apart so as to allow the stain to penetrate; pour off stain, and wash with sterilised water, and then with equal parts of glycerol, alcohol, and water; remove this and put a drop of same mixture on a clean cover-glass, put stained mass into it, and invert on a clean glass slide, when it can be examined with the microscope. Dr. Leon Williams has done good work, and greatly enhanced our knowledge in respect to the pathology of the enamel, and likewise in regard to the bacteriology of the mouth generally.

Mr. Goadby, having received a grant from the British Medical Association, has recently been making investigations in regard to the bacteria of the mouth, and has succeeded in cultivating bacillus maximus buccalis (leptothrix buccalis maxima of Miller), spirillum sputugenum, and spirochæta dentum, by growing them on potato gelatine, and by so doing has demonstrated that leptothrix thread forms of various bacteria are just involution forms of various bacilli, etc., found in the oral cavity. It might be noted here that bacillus maximus buccalis occurs especially in dirty and unclean mouths full of carious teeth. Spirillum sputugenum had never before been cultivated, therefore to Mr. Goadby is due the credit of having been the first to do so. He obtained in twenty-four hours beautiful spiral and coma forms of this organism. Some years ago the coma bacilli of the mouth were supposed to be the same as the true cholera organism. Goadby clearly defines the differences between them. Spirochæta dentum is frequently found in the pus of alveolar abscess and in chronic empyema of the antrum, while spirillum sputugenum is always found associated with inflamed and filthy conditions of the oral cavity. Mr. Goadby by his research has materially advanced our knowledge of dental caries, and classifies the microbes into (1) acid-forming bacteria, (2) bacteria which liquefy blood-serum, (3) pigment-forming bacteria, and insists that both the superficial and deep layers of carious tissue should be used to grow cultures from, searing each surface with a hot iron previous to taking material therefrom. Mr. Goadby has noted nine acid-forming bacteria, all of which, with two exceptions, streptococcus brevis and bacillus necrodentalis, were found in the superficial layers. As regards the second group, liquefying bacteria, he found six, of which bacillus mesentericus ruber and vulgatus liquefy blood-serum and dentine, bacillus mesentericus fuscus and bacillus furvus Goadby liquefy both blood-serum and dentine. Besides these, two other organisms were noted: the yellow bacillus Goadby, supposed to be Miller's bacillus gingivæ pyogenes, and bacillus fluorescens motilis. Constantly associated with these organisms he found an organism commonly found in sewage, cladothrix dichotoma; and other varieties of putrefactive bacteria have been found by him in the human mouth, and also in those of monkeys, associated with dental caries. All caries organisms grow best when the culture material is alkaline and contains

carbohydrates. Choquet has recently shown that recurrent dental caries can be produced in a sound tooth cavity, and below a tight filling, by placing a small metal cap of culture material on the bottom of the cavity previous to filling it, but owing to the absence of carbohydrates this secondary caries seems to advance very slowly and affects only a limited area.

Neuralgias of Dental Origin

Certain individuals seem to have a neuralgic tendency, the slightest cause interfering with perfect health inducing an attack, and there is nothing more certain than that conditions of debility, anæmia, malaria, or exhaustion are fertile sources for originating this complaint in subjects prone to it. When it has its origin in the branches of the fifth nerve it is termed trifacial neuralgia — supraorbital, infraorbital, temporal, aural, or cervical being the regions most affected. And any tooth or teeth in a diseased or irritable condition are liable to originate an attack. Careful examination requires to be made of all the teeth in order to diagnose the origin of such neuralgic conditions. The teeth, one by one, should be thoroughly examined with a fine probe, and percussed by a steel instrument, while conditions of chronic pulpitis, exostosis, chronic periodontitis, or impacted third molars must not be overlooked. Projection of a stream of cold water against a suspected tooth may help to show up inflammatory conditions of the pulp. Carious, suppurating, and broken-down wisdom teeth are common sources of neuralgic trouble.

Neuralgic pain, when occurring in the supraorbital or infraorbital regions, is usually due to maxillary teeth, whereas pain in the ear, neck, or shoulder indicates disease of some of the teeth in the mandible. The pain of neuralgia is of a sharp, paroxysmal, darting, or burning character, and sometimes the attacks come on at stated periods and intervals.

The pathological conditions of teeth which more especially are the cause of neuralgia are: (1) irritation of the pulp; (2) chronic pulpitis; (3) chronic periodontitis; (4) the various forms of secondary dentine found in the pulp chamber, especially that form called dentine excrescence and calcareous granules; (5) exostosis; (6) impacted third molars. It is frequently very difficult to differentiate between neuralgias of a general or dental origin. A preliminary dose or two of tincture gelsemium is sometimes of use in diagnosis, as it gives relief in most cases of dental origin, but is of no effect in systemic conditions. The treatment of the various pathological conditions of the teeth, in so far as this can be done, quickly allays and stops short the neuralgic symptoms, but while it lasts relief can be obtained by the administration of phenacetin or tincture gelsemium. Neuralgic pain may be reflected from one nerve to another, and produce pain at a considerable distance from its origin, such as the neck, the arm, or back. The usual sites of the affection are at the outlets of the main branches of the fifth nerve on the face and head. Facial paralysis is a pretty common affection, as a result of diseased and abscessed mandibular molars. The author has seen a case of muscular paralysis of the arm which was cured by the extraction of a diseased mandibular third molar. Various affections of the eye, according to Power, are caused by the presence of suppurating teeth in the maxilla.

Antral Empyema. — The maxillary antrum is very variable in size; sometimes the two sinuses differ in size in the same individual. The antrum is of pyramidal shape, and is situated above the roots of the posterior teeth and below the orbit. The proximity of the roots of the posterior teeth to the cavity of the antrum (which they sometimes penetrate) is frequently the origin of trouble in this sinus, by causing irritation and alteration of the normal secretion, which becomes purulent in character, and is evacuated through the middle meatus into the nose, or in some cases a sinus discharges through an opening in the external alveolar process or palate. Antral empyema may also have its origin as an extension of disease from the nasal cavity without any of the teeth being diseased; but its most frequent origin is from diseased and septic roots or teeth, especially the posterior teeth, although any of the other teeth may cause it.

Acute Antral Empyema.—Except as a result of scarlet fever or influenza this variety is somewhat uncommon.

Symptoms.—Great pain of a throbbing or neuralgic character is experienced, accompanied by high temperature and pain in the teeth. Relief for the time being is obtained by evacuating the cavity. Operative measures are seldom required, as the disease ceases spontaneously.

Chronic empyema is very common and often overlooked. Symptoms: slight feeling of pain or tension over the cheek, nose, or supraorbital ridge, nasal discharge of fœtid pus, the frequent passage of which over the nasal mucous membrane irritates and inflames it; one or both nostrils may be blocked. It often requires prolonged treatment and is difficult to cure.

Treatment.— Remove thoroughly all diseased teeth, and bore a hole with a suitable instrument (a large trocar will do) through the external alveolar plate over the first or second molar tooth into the antrum. A good-sized opening is required for successfully treating it. The antral cavity should then be, in the first place, washed out with dilute 3 per cent solution of pyrozone to cleanse the mucous membrane from pus, etc.; then follow this up with a hot solution of boracic acid, or a teaspoonful of hydronaphthol solution in a tumbler of water may be used. This may be done three or four

times daily, using an enema syringe. In chronic cases curetting the cavity is useful, or painting the membrane with equal parts of tincture of iodine and carbolic acid. If these measures fail to arrest the suppuration the antrum should be packed with aristol gauze till suppuration ceases. To exclude food, etc., from the antrum, a plate should be adapted to the mouth, carrying a tube or plug fitting the opening. In cases of antral empyema, where the teeth are all sound, an opening may be made into the antrum through the canine fossa, though the drainage from this part of the antrum is not nearly so good. Some authorities recommend opening through the nose (Max, Hall, etc.).

Tooth Extraction. Hæmorrhage

In extracting teeth with forceps the rules to remember are to press the instrument forcibly upwards or downwards, as the case may be, keeping up this pressure during the whole time the lateral movements are being made, while

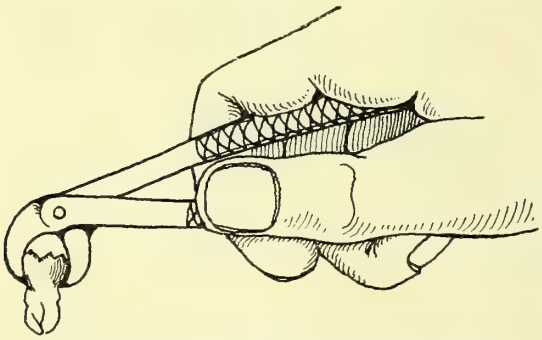


Fig. 16.—Method of holding hawksbill forceps for extracting a molar tooth.

one or two fingers should be placed between the handles of forceps to regulate the pressure applied to the tooth (Fig. 16). In the maxilla the only teeth that can be rotated in extracting are the canines and central incisors; all the other teeth, both in the maxilla and mandible, except inferior canine, are best removed by an inward and outward, more especially outward, movement, the external alveolar process being thinnest and yielding more readily. Hawksbill root forceps are usually employed for the extraction of all mandibular teeth up to the second premolar, while hawksbill molar forceps are employed for the posterior teeth (Fig. 16). In using the hawksbill molar forceps for, say, the extraction of the first molar, the tooth should be grasped, and the index and other fingers of left hand should rest on the teeth and inner surface of alveolar ridge, and the thumb should be used to forcibly press down the beaks of instrument. Root forceps are usually employed for the extraction of the maxillary teeth up to the second premolar; the usual beaked forceps are used for the molars (Figs. 17, 18, 19). For the extraction of roots where forceps are of no avail, the elevator, straight and curved, is very useful. The straight elevator is invaluable in the removal of mal-placed wisdom or other teeth in the mandible, and is used thus: it is gradually, and with a somewhat rotatory movement,

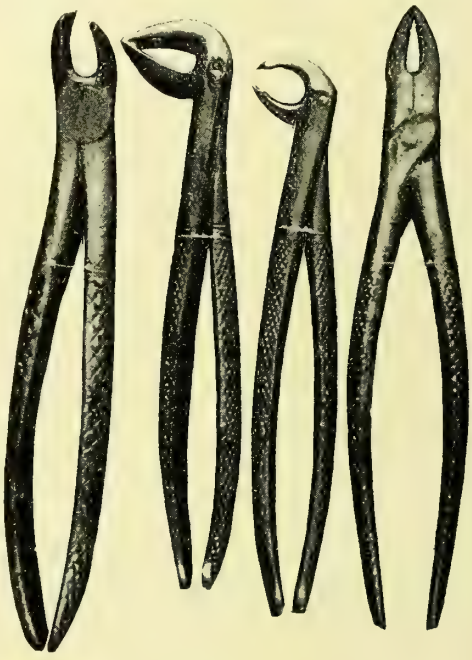
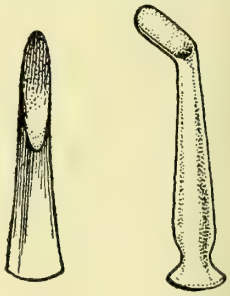


Fig. 18. Fig. 17. Fig. 19.

forced well down between the tooth and its socket, then leverage is applied, which gradually forces the tooth out of its socket (Fig. 20).

Alveolar Hæmorrhage. — Hæmorrhage after tooth extraction is sometimes troublesome, especially in patients of a hæmorrhagic diathesis, in which class of cases it is advisable, as a preventive, to prepare the patient, prior to the removal of a tooth, by administering twice daily one 4-gr. acetate of lead pill for a week previous to the operation, or doses of tannic acid; and to make sure, the sockets of tooth, after extraction, should be separately packed with narrow strips of lint saturated with Richardson's styptic colloid, a preparation which almost invariably checks hæmorrhage. Adrenalin chloride is also very valuable to allay hæmorrhage.



Straight elevator. Curved elevator.

Fig. 20.

Hæmorrhage, as to cause, may be either traumatic or vicarious of some other blood-flow. In very obstinate cases, after plugging the sockets, a piece of cork may be fitted between the two teeth on either side and the jaws bandaged, so

that the opposing teeth may keep up pressure on the cork, or a piece of softened guttapercha may be moulded and applied in like manner. The capillary ooze from the gum is sometimes more troublesome to control than the alveolar.

Local anæsthetics used in tooth extraction are—

Chloride of ethyl, which is sprayed on the gum from a tube, and is sometimes of use, especially for the removal of loose teeth.

Eucaine.—A solution in water is greatly used, hypodermically applied; it has little or no toxic effect, and is preferable to cocaine. If several teeth have to be extracted, three or four different injections at various points over the roots of the teeth should be given, and in five or seven minutes the teeth can be removed.

Nitrous oxide gas as a general anæsthetic is very extensively used by dental practitioners, but the author prefers a mixture of N_2O, 1 part, to 1 part of O. The anæsthesia is more prolonged than with N_2O alone; there is no stertor nor cyanosis, and no spasms of the muscles. N_2O anæsthesia may also be kept up by the application, after removal of the face-piece, of a nose-piece through which the gas is administered, and it can thus be prolonged so that nearly the whole of the teeth in the jaws can be extracted at one sitting. It is of no use, however, in cases where there is nasal obstruction. N_2O and ether for prolonging anæsthesia is greatly used and gives very good results; along with ether it forms the principal anæsthetic agent now employed at the Edinburgh Dental Hospital for dental operations. Kelene, a form of pure ethyl chloride, inhaled through a special face-piece, is sometimes employed, and is both very simple and efficient, and is useful to employ for outside cases where the taking about the gas apparatus is troublesome. No disagreeable effects seem to be caused by its use, and from two to eleven teeth can be extracted under the anæsthetic.

Mechanical Dentistry

Dentistry is a very old profession, and was practised by the Romans at a very early period, as we learn from the Twelve Tablets promulgated about 450 B.C. In it mention is made of the fixation of loose teeth by means of gold wires, a common proceeding in those days. In the Museum of Corneto, Italy, there are two plates with artificial teeth attached, which were got from an Etruscan and Roman tomb respectively, dating back to the fourth or fifth century B.C. The teeth, which are carved out of ivory, are fixed upon a thin flexible ribbon of gold.

Owing to the great destruction of teeth from caries in the present day, immense quantities of porcelain teeth are required yearly to meet the demand. Artificial teeth in the present day are all made of porcelain. Fifty or sixty years ago natural teeth, or teeth carved out of walrus or other tusks, were largely used, but had the fault of becoming carious, and so did not last any time. Porcelain teeth are mainly made up of a mixture of kaolin, silica, feldspar, and oxide of titanium, the glazed enamel surface being made with feldspar and various colouring matters to produce the shades. The teeth are made in moulds and then fired; each tooth has two platinum pins baked into it for fixing them to the various base plates they may be put on.

The mouth should be prepared for the insertion of artificial teeth by the removal of all useless or diseased roots, and the treatment and filling of all savable teeth, to prevent caries and abscess; the six front maxillary roots should be treated and filled if possible, as their retention does not alter the mouth so much, and does not necessitate an artificial gum. After preparation of the mouth the model is taken. The best material for this purpose, especially in edentulous patients, is plaster of Paris; but modelling composition made up of gum-kowrie, stearin, chalk, and colouring is also extensively employed. Everything depends on the model being accurate, otherwise the plate will not fit. After the model is cast it is dried and boiled in liquid bees'-wax or stearin to harden the surface, and if a metal plate has to be made casts of the model in zinc are taken in sand, and a counter of lead made to fit it, between which the metal plate is swaged and struck up till it fits the model perfectly; it is then filed up to shape, and the teeth, backed with platinum or gold, are fitted to the gum, waxed into position on the plate, and articulated; then the plate and teeth are embedded in a mixture of plaster and diatomite, leaving the backs of teeth and palate of plate exposed. When hard the wax is removed, and the whole gradually heated up till red-hot on a fire or gas-burner, and each tooth soldered to the plate with gold solder by means of a blowpipe; after which the plate is finished and polished. For the retention of partial dentures the teeth are fitted with clasps of springy gold, but as these sometimes act injuriously on the teeth it is better, if possible, to retain the plate with flexible gold wings, carefully adapted, high up on the external alveolar border, and running from behind forwards. When a vulcanite denture is made a wax plate is prepared to fit the model, then the teeth are ground and fitted to the gum, waxed to plate, and articulated to the bite; after smoothing and finishing, it, along with the model, is embedded in plaster in the lower half of a flask, all the teeth being covered with plaster up to their inner surfaces, but leaving the palatine surface of wax-plate exposed. When the plaster has set it is smoothed and greased, and the other half of flask put on and filled up with plaster; when hard the two halves are separated, the wax-plate all removed

with boiling water, and vulcanite rubber is cut in suitable pieces and packed into every part of it till full; the flask is now heated and compressed, and is ready for vulcanisation, which consists in subjecting the flask and contents to a temperature of 315° to 320° F. for an hour and a quarter in a steam boiler, which converts it into hard vulcanite. After cooling and removal from the flask it is scraped, filed, and polished. In the case of full-suction sets the models should always be taken with plaster, as it causes less disturbance of the soft parts, and great care requires to be taken in getting the correct bite and proper articulation of the teeth.

Gold springs and swivels are sometimes employed for attaching the two dentures to each other, but in the majority of cases springs are not required, except perhaps with very old people, because, if the adaptation and model be correct, suction-plates ought to keep in place perfectly. Suction-cells for retention of the upper plate are used by many, but are of little value, and have been known, by their irritation, to originate malignant disease. Badly adapted plates cutting into the soft tissues are a source of danger, as they are sometimes neglected, and produce troublesome ulcerations which are prone to become malignant.

Bridge and Bar Work

This method of inserting artificial teeth has, during recent years, been much exploited by the more unscrupulous class of practitioners, who insert bridge work in all and sundry, whether the case is adapted for it or not, and without proper treatment of the roots and teeth of attachment (Fig. 21). The method is this: In a mouth, say, with a molar on either side left, and two canine roots, the two sound molars are cut down and caps of gold are fitted over them, the two roots are treated and cut level with the gum, and their root canals enlarged; platinum caps are now fitted to each root, and a tube running up each canal is soldered to them, and the two cemented into position. A stout platinum bar is fitted to go from molar to molar, soldered to each cap and to the two metal posts fitted to each tube in roots. Backed teeth are now adjusted, fixed in position, and soldered to the bar, and when finished and polished it is cemented into place. The objections to this class of work are: the difficulties of repairing and keeping it properly clean, the maiming of sound teeth is a decidedly objectionable feature, and if badly adjusted the strain on the teeth to which the bridge is fixed gradually loosens them. Movable bridge work, when it can be applied, is not quite so objectionable (Fig. 21). Pivots are used extensively for the six front teeth, the pulp is destroyed and removed, the root canal enlarged, and the apex sealed up with guttapercha; a post of gold or platinum is adapted to the root canal, and soldered to a platinum cap made to fit the root surface, which has previously been filed down a little below the gum level in front, but not so much behind, then a backed half tooth is fitted over the cap and to the gum, and soldered to it, building the back up with gold to a contour; after being filed up and polished it is made fast in the root with cement or guttapercha. All porcelain crowns are extensively used also, especially premolars and molars. A square post is fitted and cemented into the root, and a tube tooth is adjusted over the root and cemented to the root and outer part of post, or the tooth may be fixed with amalgam. Other porcelain crowns have platinum posts embedded in the tooth, which, along with the tooth, are fitted to the root, and then fixed into place with cement, etc. All-gold crowns are principally used for the posterior teeth, and are best adapted for roots which have a portion of the tooth remaining above the level of the gum. A ferule of 22-carat gold is fitted to go below the edge of the gum and fit tightly to the root, and with crown punches a top is struck up, strengthened, and soldered to the ferule, which, on being filed, polished, and fixed, makes a very good and serviceable crown.

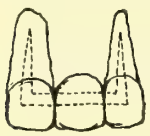


Fig. 21.—Small bridge-work plate attached to roots of central and lateral incisor.

Gold and porcelain crowns are sometimes made from all-gold crowns by cutting out the outer metal wall, and fitting into it and soldering a half tooth which has been backed with gold. They are very much more presentable than all-gold crowns, and should be used near the front of the mouth in preference to the all-gold crown.

Teething. *See* Children, Development of (*Dentition, Symptoms, Treatment*); Gastro-Intestinal Disorders of Infancy (*Ailments of Dentition*); Rickets (*Clinical Features*); Syphilis (*In Children, Later Signs*); Teeth (*Genesis of the Teeth, Eruption*).

Tegmen.—A covering, *e.g.* the *tegmen tympani* or thin plate of bone roofing in the cavity of the tympanum.

Tegmentum.—A covering (Lat. *tegere*, to cover); *e.g.* the tegmenta of the crura cerebri, which are separated from the crusta by the substantia nigra. *See* Auditory Nerve and Labyrinth (*Nerve Deafness, Seat of Lesion*); Physiology, Central Nervous System (*Crura Cerebri*).

Tegumentary.—Relating to the skin (*q.v.*).

Teichmann's Crystals.—Hæmin, a crystalline hydrochloride of hæmatin. *See* Fæces (*Abnormalities, Foreign Bodies, Blood*).

Teichmann's Test.—The hæmin test for the presence of blood.

Teichopsia. — Transitory amblyopia, characterised by the sensation of zigzag flashes of light, arranged in rampart fashion (Gr. τεῖχος, a wall or rampart, and ὄψις, vision). *See* Amblyopia (*Functional, Transitory*).

Tela.—A web, or a tissue; *e.g.* tela cellulosa (areolar tissue), tela choroidea superior (the velum interpositum or roof of the third ventricle of the brain), and tela choroidea inferior (the pia mater, covering the lower part of the roof of the fourth ventricle).

Telangiectasis.—A vascular tumour (congenital in origin) consisting of dilated capillaries and small vessels. *See* Capillaries, Diseases of (*Congenital Angioma*).

Telangiectatic.—Resembling a telangiectasis or congenital angioma, *e.g.* telangiectatic lupus. *See* Lupus Erythematosus (*Description*).

Telangioma.—A tumour composed of dilated capillaries. *See* Telangiectasis.

Telegony.—The alleged influence of a previous husband or sire upon the progeny produced by a second one from the same mother (Gr. τῆλε, far off, γονή, offspring); it is the name given to those doubtful cases in which the offspring is said to resemble not the father but an early mate of the mother either in physiological or in pathological peculiarities. *See* Heredity (*Telegony*); Maternal Impressions (*Telegony*).

Telegraphist's Cramp. *See* Neuroses, Occupation (*Etiology*).

Telencephalon.—The anterior part of the fore-brain or prosencephalon, consisting of the cerebral hemispheres, olfactory lobes, lateral ventricles, foramina of Monro, and the anterior portion of the third ventricle.

Teleology.—The science or doctrine of final causes.

Telepathy.—The alleged action of one mind upon another at a distance such as to exclude the usual modes of influence through sight, hearing, etc.; thought transference.

Telephone Tinnitus.—Tinnitus aurium ascribed to the frequent use of the telephone.

Telescopic Vision. *See* Colour Vision (*Acquired Restriction of Form Vision*).

Telo-.—In compound words *telo-* (Gr. τέλος, end) means relating to the end or terminal; e.g. *telodendron* (one of the bulbous expansions terminating the arborisation of an axon), *telolecithal* (the term applied to an ovum having much food-yolk eccentric in position), etc.

Telosporidia. *See* Parasites (*Sporozoa, Telosporidia*).

Temperament.—A special constitution or complexion or diathesis; *e.g.* the nervous, lymphatic, bilious, sanguine, or melancholic temperaments, which predispose the individual to certain diseases or to certain ways of exhibiting diseases.

Temperature.

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See also Alcohol (*Physiology, Temperature*); Anæsthesia, General Physiology of (*Remote Effects, Temperature*); Aorta, Aneurysm and Dilatation of (*Symptoms, Rises of Temperature*); Appendix Vermiformis (*Abscess Fever*); Brain, Tumours of (*Localising Symptoms, Temperature*); Brain, Surgery of (*Compression, Temperature*); Brain, Surgery of (*Cerebral Abscess*); Children, Development of (*Sensibility to Temperature*); Children, Clinical Examination of (*Temperature*); Cholera, Epidemic (*Symptoms*); Liver, Tropical Abscess (*Symptoms*); Measles (*Symptoms, Temperature*); Medicine, Forensic (*Signs of Death*); Meteorology (*Temperature*); Peritoneum, Acute Peritonitis, General (*Symptoms, Temperature*); Puerperium, Physiology (*Changes in Maternal System, Temperature*); Puerperium, Pathology (*Infection, Vulvitis*, etc.); Pulse (*Frequency*); Typhoid Fever (*Symptoms*); Typhus Fever (*Period of Advance*, etc.); Uræmia (*Symptoms*).

The temperature of the body is the degree of bodily heat registered by the thermometer. The temperature of the internal parts of the body is higher than that of the more superficial or peripheral parts. In man the normal temperature taken in the mouth or axilla is 98·4° to 98·6° F. (37° C.); the average temperature taken in the rectum is 99·3° F. (37·4° C.), whereas the skin temperature varies from 81° to 89·6° F.

As there is constant production of heat within the body, the result of tissue metabolism, it is evident that there must likewise be constant loss of heat. The temperature of any part of the body is largely dependent on the amount of blood circulating through the part, and

consequently on the degree of dilatation or contraction of its blood-vessels.

Division of the sympathetic in the neck of the rabbit is followed by dilatation of the blood-vessels and elevation of temperature in the ear of the same side, whereas irritation of the peripheral end of the divided nerve causes contraction of the blood-vessels in the ear with a fall of temperature in the part.

The constancy of the temperature of the body is due to the intimate relationship between the amount of heat produced and that lost from the body. Loss of heat occurs to a considerable extent from the lungs, but is chiefly due to radiation, conduction, and evaporation from the skin. The loss of heat by evaporation diminishes the more moisture there is in the atmosphere, hence a high temperature of the atmosphere is more readily withstood the less moisture it contains. The loss of heat from the skin is reduced by clothing, but apart from this, the loss of warmth from the skin is automatically regulated. Exposure to cold tending to cause loss of heat from the skin surface, induces at the same time contraction of the cutaneous blood-vessels, and thereby lowers the temperature of the skin, diminishes the evaporation of moisture from it, and checks the loss of heat from the body. On the other hand, if the temperature of the medium surrounding the body be high, the blood-vessels of the skin dilate, the amount of blood circulating through the skin is much increased, and there is consequently increased loss of heat from the surface of the body. Thus, in the event of circumstances tending to cause a rise of temperature, there is a compensating lowering of the temperature; or if there be a tendency for the temperature to fall, there is a simultaneous and compensating rise of temperature. In this manner the range of temperature in normal individuals is very slight, a rise or fall of temperature is of brief duration, and the normal temperature is quickly re-established.

The Temperature in Relation to Age.— In new-born infants the mean temperature is 99·0° to 99·6° F., and in both infancy and childhood variations in temperature are more frequent and more pronounced than in later life. New-born infants not infrequently present an evening rise of 0·9° F. In advanced life the temperature is often slightly higher than in the normal adult, being usually about 99° to 99·5° F.

Diurnal variations of temperature occur both in health and in disease. In the former, and probably also in the latter, the variation is mainly dependent on muscular movements and ingestion of food. According to Ogle the minimum temperature in health is about 6 A.M. (97·2° F.). A rise of temperature then commences and continues until the maximum temperature (about 98·7° F.) is attained between 3 and 5 P.M., and thereafter the temperature again falls. Jürgensen observed the daily minimum between 2 and 8 A.M., the daily maximum between 4 and 9 P.M.

The temperature is uninfluenced by the sex of the individual. Menstruation causes a very slight and transient rise of temperature; pregnancy has no effect on the temperature. During parturition there is a rise of about $\frac{1}{10}$° F.; during the normal puerperium the temperature remains the same as that of other normal women.

Tea and coffee induce a slight rise, usually about $\frac{1}{2}$° F. or less; alcohol in large doses lowers the temperature in consequence of dilatation of the superficial blood-vessels, and of oxidation being retarded, but after this fall the temperature rises to a higher level than formerly.

Localised Abnormal Temperature. — A localised abnormality of temperature is most frequently and readily observed in a peripheral part of the body such as the limbs. The two chief factors concerned in bringing about this change are the vascular and the nervous supply of the part. Arrest of blood-supply, as by ligature of the main artery to the part, causes a marked fall of temperature locally, which is in turn succeeded by a rise as the collateral circulation becomes established. Disease of the blood-vessels, causing diminution of blood-supply to a part of the body, is usually accompanied by a fall of temperature in the affected part. Such a change is well seen in the fingers in Raynaud's disease, and may be observed in cases of advanced arterio-sclerosis. Paralysis of a peripheral nerve, whether resulting from section or injury of the nerve trunk, neuritis, or other lesion of the lower neuron of the motor path, is frequently accompanied by diminution of the temperature in the paralysed part, and the difference between the surface temperature of the healthy and of the paralysed side may amount to 10°, 15°, or 20° F.

A localised elevation of temperature is essentially due to an increased volume of arterial blood in the part. Claude Bernard's classical experiment on division of the sympathetic in the neck of the rabbit with consequent elevation of temperature of the ear on the same side has been already mentioned. A localised elevation of temperature consequent on local dilatation of the blood-vessels is observed in association with cutaneous hyperæmia of superficial parts, whether it be induced by mechanical means or be a manifestation of inflammation, but the temperature of the affected part is never higher than the general temperature of the body.

Alterations of General Temperature.— The general temperature of the body may either fall below or rise above the normal level.

A. *Depression.*—It is evident that a fall of the general temperature may be due (1) to

diminished production of bodily heat; (2) to excessive loss of heat; or (3) to these two processes acting in combination; but it is not always possible to determine to which of these factors depression of the general temperature is due. The fall of temperature consequent on extensive burns of the skin is, however, due to increased loss of heat dependent on paralytic dilatation of the blood-vessels in the injured parts. Prolonged *exposure to cold* also causes excessive loss of heat from the body; and if this loss be continued for a long period, the temperature of the body may be reduced to such a degree that the life of the individual is endangered, or that death ensues. In animals, death from freezing is mainly due to paralysis of respiration, for by means of artificial respiration the animals can be kept alive for longer periods than they could otherwise be. The temperature falls after the occurrence of a severe *hæmorrhage*. In animals a hæmorrhage of moderate amount causes the temperature to fall about 1·5° to 1·8° F. This fall is maintained for a few hours, but thereafter the temperature rises to a higher level than that existing before the hæmorrhage occurred. The loss of a larger quantity of blood is followed by a rapid and marked fall of temperature, whether the temperature previously has been normal or elevated. Such a fall of temperature is of great significance in typhoid fever, and in duodenal and many cases of gastric ulceration.

Starvation and *vomiting* lower the temperature. In *collapse* there is a marked fall of temperature due chiefly to rapid and excessive loss of heat. In severe collapse, associated with serious danger to the life of the patient, the temperature may fall to about 93° F. In many patients suffering from chronic diseases the temperature is subnormal. Examples are seen in cases of chronic nephritis, cerebral abscess, and enteritis, though in the latter condition a febrile temperature is not uncommon, especially in children. In such cases depression of the temperature is due more to deficient production of heat than to excessive loss of heat. A reduction of temperature can be effected by certain *drugs*—alcohol, chloroform, ether, opium, and chloral, for example. The group of drugs termed antipyretics, which bring about a reduction of an elevated temperature, have little if any effect in rendering a normal temperature subnormal. The antipyretics will be again referred to in dealing with the treatment of fever.

B. *Elevation of the General Temperature.*—Elevation of the general temperature may be induced (1) by increased heat production, (2) by diminished loss of heat, or (3) by these two processes in combination. The term fever is employed by some writers to signify elevation of temperature induced by no matter what cause, but it is more usual not to regard mere elevation of temperature, or hyperthermia, and fever as synonymous terms, but to reserve the term fever for a general disturbance of metabolism, one of the main features of which is an abnormal elevation of temperature. It must, however, be admitted that in some instances it is difficult or impossible to determine whether the elevation of temperature is a simple hyperthermia or a febrile pyrexia.

Hyperthermia may be induced by muscular exertion, exposure to high temperatures, or by lesions of the central nervous system.

Muscular exertion, especially if prolonged, causes a rise of temperature by increasing the production of heat within the body. Sutherland Simpson has recorded the fact that muscular exercise in the monkey causes the rectal temperature to rise from 3° to 4° F. In man active muscular exercise causes an elevation of temperature of about 0·5° to 2° F. This hyperthermia, due to increase of metabolism in the muscular tissues, ceases simultaneously with, or very soon after, the muscular exercise is discontinued, provided the individual be in normal health. If, however, he be affected with some morbid condition, or be convalescing from disease, muscular exertion not only tends to induce a more marked rise of temperature, but this elevation tends to persist for a varying period of time after cessation from the muscular exercise.

On exposure to an atmosphere of a high temperature, which tends to raise the general temperature of the body, there is, as already mentioned, a simultaneous and compensatory excess of heat lost from the skin. But prolonged exposure to a very high temperature cannot be withstood without harm resulting. If guinea-pigs be exposed to a temperature of 104° to 107° F. their temperature rises to 107° to 113° F., and the animals die; whereas if animals be exposed to a gradually increasing high temperature they remain alive even though the temperature of the atmosphere be raised to 105° to 107° F. After exposure to such a temperature there is marked degeneration of the red blood corpuscles and fatty degeneration of the parenchyma of the liver, heart, and kidneys, but the blood pressure may remain normal. If the human subject be exposed to a temperature of 122° F. his temperature rises to 107° F. or still higher, and death may ensue. Similarly in the case of sunstroke the temperature, in consequence of diminished loss of heat, rises, it may be, to 104°, 105°, or even to 113° F. The skin is hot and dry, the respiratory and cardiac frequency are both markedly increased, and there is increased excretion of urea from the kidneys. The increased rapidity of the respiration is usually ascribed to the heat of the skin stimulating the respiratory centre reflexly.

Hyperthermia of Nervous Origin.—The experiments of Wood, Eulenberg, and Landois, Bokai, and others, on the production of hyperthermia

by injuries to the cerebral cortex are inconclusive, the high temperature being probably due to muscular movements of the animals, or to the epileptiform attacks induced by cortical stimulation. Aronsohn and Sachs, Ott and Hale White found that in animals lesions of the corpus striatum are followed by a rise of temperature to 107° F. or more. Both clinical and experimental evidence indicates, however, that there are no specific thermogenic centres or centre within the central nervous system. A cerebral lesion associated with hyperthermia is probably in every instance an irritative lesion, but whether the hyperthermia be the result of increased chemical activity in the muscles or glandular organs, or be dependent on diminished loss of heat, is still unascertained. In man hyperthermia is seen in association with injuries to the cerebral cortex, corpus striatum, or crus cerebri, with lesions of the pons and medulla, and also sometimes with hysteria, epilepsy, and general paralysis. In hysteria the temperature may rise to 106° F., being in some instances associated with convulsive attacks. In diseases associated with a febrile elevation of temperature there is in some instances a rise of temperature to 107° F. or more, constituting the condition known as *hyperpyrexia*. The hyperpyretic temperature is by some regarded as representing the joint result of the febrile temperature and of a hyperthermia of nervous origin.

Fever.—In fever there is a general disturbance of metabolism with elevation of the temperature (pyrexia), disturbance of the circulation and respiration, alterations in the blood and urinary secretions, and changes in the parenchyma of the internal organs. The functional and structural changes are due to the exciting cause of the fever, and are not the result of the rise of temperature.

Elevation of the temperature is the most important and characteristic sign of fever. The rise of temperature is probably not in all cases induced in the same manner, though this is a point on which different investigators do not agree. It is usual to describe three stages in the course of the febrile temperature:—

(1) The initial stage of rise, pyrogenetic stage, or stadium incrementi. In this stage the cutaneous blood-vessels become contracted in consequence of the action of the exciting cause on the vaso-motor centre, and the vascular constriction becoming more pronounced, there is diminished loss of heat from the body, and the temperature commences to rise, and continues to do so the more markedly the cutaneous blood-vessels become constricted. The initial rise of temperature is therefore dependent on a diminution in the loss of heat. If this constriction of the cutaneous blood-vessels be rapidly induced the general temperature rises rapidly, as in scarlet fever or acute lobar pneumonia, whilst there is a fall of temperature in the peripheral parts, pallor of the skin, a sensation of cold, and a rigor which ceases before the temperature has attained its maximal point. If the exciting cause of the fever induces a gradual constriction of the blood-vessels, the initial rise of temperature is not sudden and is not associated with a rigor, but is gradual, slow, and more or less insidious. It is either a gradual but steady rise, or there are several more or less well-marked remissions, after each of which the temperature rises to a higher level than it had previously attained. The best illustration of such a step-like rise is seen in the temperature during the first week of typhoid fever.

(2) The stage of acme, or the fastigium, during which the temperature remains elevated, though varying according to the exciting cause. During this stage of fever there is an increase both in the production and in the loss of heat, an increase which, according to Krehl and Matthes, is on an average equal to 20 per cent. But even though there be, as compared with the normal, an increased loss of heat, the loss is insufficient to entirely compensate the excess of heat produced, and the temperature is consequently above the normal level. In many instances the skin is dry, and evaporation of moisture from the surface of the body is diminished, and the loss of heat is, in comparison with the production of heat, relatively diminished. During this stage the height to which the temperature rises, and the general course of the temperature, are dependent on the exciting cause; but the same cause may not induce an identically similar reaction in every case, as different individuals may react to the same cause in a different manner. There are a number of "clinical types" of febrile temperature according to the course of the latter. Thus the temperature may remain at a high level for a short period, varying from some hours to a few days, after which it rapidly falls. This type is termed accuminated, and is observed in many acute infective diseases of short duration. Again, the temperature for a prolonged period may remain persistently high, with diurnal variations. This is the continuous type of temperature, examples being the temperature of typhus fever, acute lobar pneumonia, and acute suppurative meningitis. Again, there may be during this stage marked fluctuations in the course of the temperature. Thus there may be a remission of the temperature in the morning and an exacerbation in the evening. In this remittent type of temperature, as in typhoid fever, for example, the temperature during the remissions does not fall to the normal level. In the true intermittent type the temperature at each successive fall reaches the normal level, examples of this type being the temperatures in malarial fever, the fever of septic origin, and advanced pulmonary tuberculosis when there is mixed infection with streptococci. In the relapsing type of febrile temperature

there is a paroxysmal elevation of temperature persisting for a few days to a week, then a rapid fall of temperature, succeeded by an interval during which the temperature remains normal, and subsequent to this interval there is again a paroxysmal rise.

(3) Defervescence, or stadium decrementi, the stage during which the temperature falls to normal. Defervescence occurs when the exciting cause of the fever ceases to act—when, for example, the causal toxin becomes completely united with the specific antitoxin. The fall of temperature is sometimes associated with marked dilatation of the cutaneous blood-vessels and with considerable sweating, and there is, in this instance, a rapid fall of temperature constituting a crisis. During a crisis there are often signs of collapse. There is not infrequently a pseudo-crisis preceding the actual crisis. In other instances defervescence takes place slowly, or, as it is termed, by lysis, and some days or even a week may elapse before the temperature has actually fallen to the normal level.

The preagonic temperature may rise to a very high level, 105° to 107° F. or more, as in cases of cerebral lesions, hæmorrhage, meningitis, etc., and in tetanus. Preagonic hyperpyrexia is possibly due to a nervous hyperthermia, consequent on cerebral disturbance, being superadded to the pre-existing pyrexia, or may be due to a terminal infection. It is more usual, however, for a temperature, which was previously high, to fall, it may be to below the normal level in the period preceding death. *After death* the temperature of the body gradually falls to that of the surrounding atmosphere. In some instances, however, there is an initial post-mortem rise of temperature which may be very pronounced (104° to 111° F.). Such a rise is, for example, seen in some cases of cerebral hæmorrhage, cerebro-spinal or tuberculous meningitis, tetanus, acute rheumatism, and other infective diseases in which there has been marked pyrexia or hyperpyrexia.

Causes of Fever.—The most frequent and important causes are bacterial toxins. Bergmann and Brieger both prepared toxic bacterial products capable of inducing febrile elevation of temperature. Donath found that a substance (pyrotoxin) of a pyrogenetic nature could be obtained from a number of bacteria such as staphylococcus pyogenes aureus, streptococcus pyogenes, and bacillus pyocyaneus; and Krehl obtained similar results in the case of bacterium coli commune, diphtheria bacillus, proteus vulgaris, and other pathogenetic and saprophytic bacteria. Tuberculin and tetanus toxin likewise induce elevation of the temperature. In contradistinction to Centanni, who considers that the pyrotoxin obtained from different bacteria is in all cases identical, Krehl holds that the pyrogenetic substances of the various bacteria are not identical in all respects. The latter view is certainly the more correct if one considers how different is the character and course of the temperature in the various febrile diseases, such as acute lobar pneumonia, acute rheumatism, diphtheria, typhoid fever, etc.

Bacterial toxins are, however, not the only cause. Pyrexia may be due to a process of autointoxication, to an abnormal absorption of products of metabolism. The pyrexia of intestinal catarrh and constipation is sometimes ascribed to autointoxication, but is more probably due to absorption of bacterial toxins from the alimentary canal. Subcutaneous injection of albumin, albumose, and peptone, and of normal urine, causes a rise of temperature in some animals; and various other substances, urea, nuclein, fibrin ferment, pepsin, trypsin, diastase, and other ferments, have a similar action. Ughetti having found that urea induces hyperthermia, concluded that the rise of temperature in fever was due to the fact that various substances bring about an increased production of urea within the body. Elevation of temperature is often observed in association with aseptic injuries and lesions of the tissues, with internal hæmorrhage, or with anæmia, constituting the form of pyrexia designated "aseptic fever," examples being the so-called urethral fever, and the fever associated with teething, simple fracture of bone, aseptic hæmothorax, hæmarthrosis, etc. In these instances we may either assume that the rise of temperature, which is by some writers interpreted as a simple hyperthermia, by others as a sign of fever, is due to the absorption of albumose, or other tissue product, from the site of injury or from the degenerating tissue cells, although the possibility of the elevation of temperature being in some instances due to reflex nervous stimulation cannot be entirely excluded.

There is very little evidence, if indeed any at all, to prove that pyrexia is harmful. On the contrary, pyrexia of moderate degree is beneficial to the patient; it is only harmful if it be severe or hyperpyrexial. Animals exposed to a high temperature after experimental inoculation with bacteria are enabled to withstand infection better than when they are kept at the room temperature (Wolther, Filehne, Rovighi, Kast, Loewy and Richter). We cannot, however, conclude that elevation of the temperature retards or inhibits the growth of pathogenetic bacteria within the body, nor that it tends to lessen or destroy the toxicity of the bacterial products; and although it has been shown that the antibody present in the blood serum of persons convalescent from typhoid fever, or of goats immunised to the *bacillus typhosus*, is more potent at a high temperature, it is not clear how the beneficial effect of a febrile elevation of temperature on the course of an infective disease is brought about.

Other Changes in the Course of Fever.—Eleva-

tion of the temperature may cause some acceleration of the pulse and respiration, but all the other changes to be described occur quite independently of the pyrexia, and are due to the same cause, namely, the toxin.

There is usually, though not invariably, increased consumption of oxygen and increased excretion of carbon dioxide by means of respiration, indicating that there is increased oxidation of the tissues of the body. But there is no constant relationship between the pyrexia and increase of metabolic activity, and the latter is not necessarily the cause of the pyrexia.

Degenerative changes in the parenchyma of the different organs can usually be demonstrated. The most frequent changes are albuminous infiltration, and fatty degeneration of the liver, kidneys, and cardiac muscle, less constantly of other glandular organs. Fatty degeneration can be induced by artificial exposure to a high temperature; but that the degenerative changes in fever are due to the causal toxin, and not to the pyrexia, is shown by the fact that the extent to which the changes occur is not proportionate to the elevation of temperature, and that the changes may be more marked after diphtheria or typhoid fever in which there has been merely moderate pyrexia, than after acute lobar pneumonia associated with a much higher elevation of temperature. Necrotic changes in the renal epithelium and in striped muscles, for example, are likewise induced by certain toxins.

Changes in the Blood.—In consequence of localised congestion of internal organs there may be a diminution in the number of red blood corpuscles per c.mm. in the peripheral blood; but there is usually more or less well-marked hæmolysis causing the anæmia so frequently associated with fever. The presence of hæmosiderin in excess in the spleen is a result of the hæmolysis. In many febrile diseases there is also well-marked leucocytosis, whereas in others, such as malaria and typhoid fever, there is no increase in the number of leucocytes in the peripheral blood, owing in some instances to the withdrawal of leucocytes towards the seat of infection in the internal organs. The blood serum sometimes contains a diminished amount of albumin, and the coagulability of the blood may be either increased or decreased. The alkalinity of the blood and of the blood serum is diminished during the course of a febrile disease, and the reduction is probably the more pronounced in proportion to the severity of the infection. During the periods of recovery and convalescence the diminution of alkalinity gives place to an increase, but if the organism be unable to withstand the infection or the toxin, the degree of alkalinity continues to fall until the fatal issue supervenes, as shown by von Rigler, after injection of diphtheria toxin, mallein, and tuberculin.

Loss of body weight is a constant and marked feature. That the loss is not due to the pyrexia is shown by the fact that a patient loses weight during the course of an infective disease, even though his temperature be maintained at or about the normal level by means of antipyretics. The loss of weight may be in part due to diminished ingestion of food, or to imperfect absorption of food, but is mainly due to degeneration or disintegration of the tissue cells consequent on the action of the causal toxin. Another result of the toxic action is seen in the increased excretion of nitrogen in the *urine*. The urinary secretion is diminished in amount, except during the initial stage of the fever; the colour is darker, the specific gravity is higher than that of normal urine, and urates are present in excess. The total amount of nitrogen excreted in the urine is increased, but except that the ammonia compounds may constitute ten to twelve per cent of the total nitrogen, instead of the normal two to five per cent, the distribution of nitrogen remains the same as in health, so that on examination of the urine it will be found that there is increased excretion of urea, uric acid, and kreatinin.

The urine frequently contains proteids. Serum albumin, together with serum globulin, is most frequently present; albumose is also not infrequent. The passage of these proteids through the glomeruli is almost certainly dependent on a morbid condition of the glomerular epithelium even though in some cases there are no visible changes in the kidneys. Ehrlich's diazo reaction can often be obtained, and the urine contains excess of the phosphoric and sulphuric acids, and may contain acetone and diacetic acid, but the chlorides are invariably reduced except in malaria, in which disease the excretion of phosphoric acid is diminished.

Circulatory Disturbances.—The heart's action is accelerated, but the increase in frequency is by no means always proportional to the pyrexia. Thus in typhoid fever the pulse may be slow and the temperature high, whereas in severe septic infection the conditions are not infrequently reversed. There is usually diminution of the blood pressure, and the pulse is dicrotic or hyperdicrotic; in other cases the blood pressure is normal or may even be increased. The circulatory disturbances are not due to the elevation of temperature alone, for in animals exposed to a high temperature both Welch and Krehl found the functional activity of the heart was normal even though there was fatty degeneration of the cardiac muscle.

Respiration is also accelerated. This change may be artificially induced by raising the temperature of the blood, or by exposing the skin to heat. But in fever marked increase of the respiratory frequency is usually dependent on indirect causes, such as cardiac enfeeblement, or inflammatory changes in some part of the respiratory tract.

Digestive Disturbances.—The salivary and gastric secretions are deficient, and the absorptive power of the stomach is diminished. There is consequently interference with the patient's appetite and digestion. Intestinal peristalsis is lessened, the hepatic cells show degenerative changes, and there is interference with the conversion of ammonium carbonate into urea, and the secretion of bile is diminished.

Cerebral phenomena—headache, inability for mental work, delirium, stupor, and coma—all due to the action of the toxins on the central nervous system, are usually well marked in fever, whereas in simple hyperthermia these phenomena are conspicuous by their absence.

Treatment of Fever.—In every case the endeavour must, if possible, be made to treat the fever specifically, but in only a few febrile diseases has this aim been hitherto attained. The patient must be carefully watched and nursed, and the diet must be light and such as can be easily assimilated. In the event of specific antitoxic treatment being impossible, the question arises as to whether the pyrexia should be treated, and if so in what manner should treatment be carried out. The view which probably at present finds most general acceptance is that pyrexia should be dealt with when it attains an excessive height, or when it has persisted, or is likely to persist, for a protracted period, but that moderate pyrexia should not receive special treatment. The drugs of the antipyretic group reduce the pyrexial temperature to normal, yet the mode of action of many of these substances is imperfectly understood. It may, however, be stated that they may act (1) by diminishing oxidation; (2) by inducing diaphoresis; (3) by destroying the causal virus or rendering its toxic product innocuous. The most efficient antipyretics are antipyrine, antifebrin, quinine, phenacetin, salicin and its compounds, aspirin, etc. Most of these drugs have a markedly depressing effect, particularly on the heart, and may induce collapse, cyanosis, fall of blood pressure, and other unfavourable symptoms. Antipyretics should therefore be employed with caution, more especially as they have no curative action, and do not shorten the duration of the disease. The employment of antipyretics is indeed less relied on now than formerly.

Diaphoresis is often beneficial in fever; it may conveniently be induced by means of the hot pack. In the application of cold to the surface of the body one possesses a reliable and safe method of lessening pyrexia. One may make use of the cold bath (temperature of 90° F. cooled down to about 70° F.), or the cold pack, or one may rub the patient with ice, or sponge with cold or tepid water. The bath or cold pack combined with ice-rubbing is the best means of treating hyperpyrexia, in which condition the free administration of alcohol is serviceable. For further information regarding the cold pack, baths, etc., *vide* the articles Balneology, vol. i., and Hydropathy, vol. iv.

Temporal.—Relating to the temple, *i.e.* the part of the head above the ear and behind the eye; *e.g.* the temporal bone, artery, lobe, nerve, region, etc. *See* Arteries, Ligature of (*Superficial Temporal*); Brain, Tumours of (*Localising Symptoms, Hearing*); Brain, Surgery of (*Cerebral Abscess from Ear Disease*); Ear, Middle, Chronic Suppuration (*Caries and Necrosis*); Stomach and Duodenum, Diseases of (*General Symptomatology, Pain in Temporal Region*); Syphilis (*Tertiary, Vascular System, Arteries*).

Temporo-.—In compound words *temporo-* (Lat. *tempus*, time) means relating to the temple or to the temporal bone, artery, nerve, etc.; e.g. *temporo-auricular* (relating to the temporal and auricular regions), *temporo-maxillary* (relating to the temporal region and the superior maxilla), *temporo-sphenoidal* (relating to the temporal and sphenoid bones), etc. *See* Brain, Physiology of (*Functions of Cerebral Cortex*); Mouth, Injuries and Diseases of the Jaw (*Diseases of Temporo-Maxillary Joint*).

Temulence.—Drunkenness or any state in disease resembling it (Lat. *temulentia*, intoxication).

Tenaculum.—A sharp hook on a handle for seizing and fixing parts, *e.g.* the cervix uteri during operations such as repair of the cervix; also a variety of artery forceps.

Tenby. *See* Therapeutics, Health Resorts (*English, Welsh*).

Tender Toes. *See* Typhoid Fever (*Complications and Sequelæ, Nervous System*).

Tendinosus.—Having the characters of a tendon, *e.g.* the semi-tendinosus muscle of the thigh.

Tendo Achillis.—The common tendon of the two calf muscles (soleus and gastrocnemius) inserted into the heel.

Tendon.—The dense fibrous structure by which a muscle is attached to a bone (Lat. *tendere*, to stretch). *See* Ankle-Joint, Region of Injuries (*Dislocation of Peroneal Tendons, Rupture of Tendo Achillis*); Ankle-Joint, Region of, Diseases (*Diseases of Tendon Sheaths*); Deformities (*Tendon Transplantation*); Hysteria (*Trophic Troubles of Tendons*); Paralysis (*Spastic Paralysis, Myotatic Irritability*); Syphilis (*Tertiary, Muscles and Tendons*).

Tendon-Jerks. *See also* Brain, Cerebellum, Affections of (*Tumour, Tendon Jerks*); Tabes Dorsalis (*Symptoms*); etc.—*Nature of the Tendon-jerks.* — The tendon-jerks, tendon

phenomena, or tendon reflexes, as they are sometimes called, first attracted attention through the writings of Erb and Westphal.

There has been much discussion regarding their nature. Some writers have held that they are true reflexes, while others have opposed this view, believing that they are due to direct stimulation of the muscles by vibrations transmitted from the tendons.

In considering this question it is convenient to take the knee-jerk as a type.

The observation that the time reaction of the knee-jerk is very much shorter than that of a true reflex has been repeatedly confirmed. Further, it has been shown that if the nerves connected with the patella tendon are divided the knee-jerk is not abolished.

For these reasons it is difficult to believe that the knee-jerk is a true reflex.

If, however, the posterior roots in the lumbar region of the spinal cord are divided in an animal, or diseased in man, as is often the case, for instance, in tabes dorsalis, the knee-jerk is found to be absent. Similarly, it is lost if the lumbar segments of the spinal cord, or the anterior roots which pass from them, or the peripheral nerves connected with the quadriceps muscle, are destroyed.

These facts show that the knee-jerk is dependent upon the integrity of a reflex arc, although, as we have seen, it is not a true reflex.

It is essential for the occurrence of a tendon-jerk that the muscle shall be in a state of slight tension which it is possible to increase by mechanical means. Thus in order to obtain the knee-jerk it is necessary to flex the knee; by this means the quadriceps is put slightly on the stretch. Further, Sir William Gowers has pointed out that although a tap on the lateral aspect of the Achillis tendon produces an Achillis-jerk, if the tendon is supported on the other side so that it cannot yield, a tap which previously caused a contraction will not now do so. This is the reason why a tendon-jerk can only be elicited in the case of certain tendons, viz. those which on account of their anatomical relations are capable of being suddenly put upon the stretch. The tendon is only of importance in so far as it allows of the tension of the muscle being suddenly increased. The proof of this is that in the case of some jerks, for example, the jaw-jerk, a tap on the bone to which the muscle is attached is equally effective. The jaw-jerk must be clearly distinguished from the so-called periosteal reflexes. The latter are true reflexes; unlike the tendon-jerks, their occurrence is not dependent on the sudden stretching of the muscle.

Finally, the most satisfactory explanation of the nature of the tendon-jerks assumes that the degree of tension in the muscle which is necessary before a tendon-jerk can be obtained induces reflexly in the muscle "a state of irritability to local mechanical stimulation" (Gowers), which manifests itself in a contraction when the muscle is suddenly put upon the stretch.

The activity of a tendon-jerk varies with, and serves as an indicator of, the state of the muscular tone (spinal *tonus*) in the muscle with which it is connected. Where there is a breach in the continuity of the spinal reflex arc the muscular *tonus* is diminished (hypotonia), as are the tendon-jerks. On the other hand, lesions of the cerebro-spinal motor tract are commonly associated with an increase in the muscular tone (hypertonia) and an exaggeration of the tendon-jerks.

The exaggeration of the tendon-jerks in the case of lesions affecting the pyramidal tracts points to a restraining influence normally exerted upon them through these fibres. Possibly the exaggeration may depend, as Hughlings Jackson has suggested, upon an unopposed cerebellar influx.

In cases of total transverse lesions of the spinal cord in man, as Bastian was the first to point out, the tendon-jerks below the level of the lesion are abolished. Their absence cannot be attributed to shock, for, unlike the temporary loss which occurs on the paralysed side after a sudden hemiplegia, they remain absent for many weeks or months. The lower limbs are hypotonic in these cases.

"Clonus" is a phenomenon which is often met with in pathological conditions in association with exaggeration of the tendon-jerks. Thus in certain cases where the foot is suddenly dorsiflexed and the pressure maintained, a series of contractions occur in the calf-muscle; this we term ankle clonus. The explanation of its occurrence is precisely similar to that of a simple jerk, the persistence of the stimulus inducing another contraction after each relaxation of the muscle.

It is important to distinguish the excitability of a muscle to mechanical stimulation applied directly to the muscle itself from that induced through its tendon.[1] "A muscle moves when struck because of its innate capacity to twitch when irritated, but it does not move when excited by a blow on its tendon unless it has, besides its own excitability, a constant influx of tone waves from spinal centres" (Weir Mitchell).

Pathological States of the Tendon-jerks.—The tendon-jerks are diminished or abolished in the following conditions:—

(1) Lesions of the spinal reflex arc.

(*a*) Lesions of the peripheral nerves, *e.g.* peripheral neuritis, or injury to the nerves which pass to and from the muscle.

[1] In cases of tabes, for instance, where the knee-jerk is absent and the quadriceps muscle hypotonic, the visible contraction of the quadriceps in response to direct percussion is often markedly increased, a point to which attention was drawn by T. Buzzard many years ago.

(*b*) Lesions of the posterior roots, *e.g.* tabes dorsalis, Friedreich's ataxy, etc.

(*c*) Lesions involving the anterior horns of the spinal cord, *e.g.* myelitis, poliomyelitis anterior acuta, progressive muscular atrophy, etc.

(*d*) Primary lesions of the muscle, *e.g.* the muscular dystrophies.

(2) Total transverse lesions of the spinal cord above the level of the reflex arc, *e.g.* fracture dislocations of the spine, pressure paraplegia produced by caries or tumour (the late stages), very occasionally as a result of acute myelitis.

(3) As a temporary condition the result of shock, *e.g.* in cases of hemiplegia of sudden onset, and in paraplegias due to a spinal hæmorrhage or an acute myelitis.

(4) During sleep, in chloroform narcosis, severe asphyxia, and coma.

(5) Occasionally in lesions of the cerebrum and cerebellum, especially tumours (probably in some cases this is accounted for by a degeneration of the spinal posterior roots).

The tendon-jerks are increased as a consequence of—

(1) Irritation of the spinal reflex arc produced by strychnine and absinthe, tetanus, the early stages of peripheral neuritis (?).

(2) Lesions of the cerebro-spinal motor tracts.

(*a*) Primary degeneration of the pyramidal tracts, *e.g.* general paralysis, amyotrophic lateral sclerosis.

(*b*) Degeneration of the pyramidal tracts secondary to a transverse lesion of the spinal cord, *e.g.* myelitis, disseminated sclerosis, spinal tumours, pressure paraplegias, etc. Déjerine has pointed out that the tendon-jerks are increased above as well as below the level of the lesion, in some cases of local disease of the spinal cord.

(*c*) Cerebral lesions, *e.g.* hemiplegia produced by hæmorrhage, embolism, thrombosis, tumours, etc. The tendon-jerks are increased on the opposite side of the body, also to a less extent on the same side, as Brissaud was the first to point out.

(3) As a temporary state after an epileptic convulsion.

(4) Hysteria, neurasthenia, and asthenic states following upon long-continued fevers, etc.

(5) During light sleep and in the early stages of asphyxia.

The examination of the tendon-jerks often affords most valuable information as to exact localisation in diseases of the spinal cord.

The Examination of the Tendon-jerks.—Before describing the methods best adapted for the examination of the individual jerks, it will be convenient, in order to avoid repetition, to emphasise certain precautions which demand attention in the case of all.

Firstly, Thoroughly relax the limb.

Secondly, Look for the contraction in the muscle, for the movement of the limb affords only a rough indication.

Thirdly, In comparing the jerks of opposite sides always make the examination with exactly similar precautions.

Fourthly, Never conclude that a jerk is absent before "reinforcement" has been tried.

The following are the means of reinforcement —the importance of which was first indicated by Jendrassik—which are most convenient for clinical purposes:—

Ask the patient to clasp his hands and pull strongly, keeping his eyes at the same time fixed upon the ceiling. If in this way the limb is not perfectly relaxed, ask him to count aloud up to a hundred, or engage him in conversation in order to withdraw his attention from the operation. A *sudden* pull on the hands is sometimes found to be of value as an aid in eliciting the jerk, the tendon being struck a second or two later.

The following are the tendon-jerks which are of chief clinical importance.

(*a*) Jaw-jerk, (*b*) biceps-jerk, (*c*) triceps-jerk, (*d*) wrist-jerk, (*e*) knee-jerk and knee clonus, (*f*) adductor-jerk, (*g*) Achillis-jerk, (*h*) ankle clonus.

We shall now consider them individually, the method of examination to be used in the case of each, and the constancy of each jerk in health.

Jaw-jerk.—Ask the patient to partially open his mouth as if about to yawn. The physician places the index-finger of his left hand across the chin and taps it with a percussion hammer or with the finger of his right hand. If the jerk is well marked there is a sudden upward movement of the jaw.

Another good method is to rest a tongue-depressor on the teeth of the lower jaw and percuss upon it.

The jaw-jerk, although, etymologically speaking, not a tendon-jerk, is of a precisely similar nature, the tension of the muscle being increased by a tap upon the bone to which it is attached.

This jerk is not constantly present in health, and its absence is not therefore of significance, unless in association with other symptoms which would lead one to expect an exaggeration.

The jaw-jerk may be increased in the conditions already referred to (p. 549). A clonus is sometimes obtained in cases of pseudo-bulbar paralysis, etc.

Biceps-jerk (C. 5-6).—Flex the patient's arm slightly, grasp it above the elbow, placing the thumb of the left hand on the biceps tendon just above the joint. Allow the patient's hand to rest against your chest, his elbow being flexed to rather more than a right angle. With the percussion hammer, which it is necessary to use for this jerk, strike the thumb which is

resting on the biceps tendon and look for a contraction in that muscle. This method the writer first learned from James Collier.

Triceps-jerk (cervical segments 6-7).—Take hold of the patient's arm by its anterior aspect, just above the elbow. Allow the forearm to hang dependent, and strike the triceps tendon close to its insertion into the olecranon.

A percussion hammer should be used in examining this jerk; a stethoscope with a rubber ring round the ear-piece will be found a convenient instrument for the purpose.

Wrist-jerk (C. 7-8).—The patient flexes his arm to a right angle, keeping the elbow close to the side and the forearm in a position of semi-pronation. The observer grasps the wrist by its ulnar aspect and strikes the radius just above the wrist; if the jerk is present the tap will be followed by a movement in the direction of flexion.

The arm-jerks above described are usually to be obtained when correctly tested. Sometimes, however, even the most careful examination fails to elicit them in a healthy individual. For this reason their absence is less significant than absence of the jerks in the lower extremities. Unilateral absence or a very obvious difference on opposite sides of the body is to be regarded as of diagnostic importance.

Occasionally in cases of cerebral disease a triceps clonus may be obtained. In some cases of rigid hemiplegia, where there is marked contracture of the fingers, a sudden and maintained extension of the fingers will produce a wrist clonus.

Knee-jerk (L. 2-4).—There are several ways of testing this jerk. That most generally employed is to tap the patella tendon while the patient is sitting with one leg crossed over the other, repeating the process in the case of the opposite leg. Or the patient may sit on a table with his legs dependent; this is a useful method for comparing the activity of the two jerks, especially in a case where there is difficulty in relaxing the hamstrings when examined in the ordinary way.

A very useful plan is as follows:—The patient, sitting on a low chair, extends both his legs as far as possible, keeping the soles of the feet and heels in contact with the ground. The slightest contraction of the quadriceps in this position produces a forward movement of the foot.

Where the patient is to be examined in bed, the best means of obtaining the jerk is to ask him to turn slightly on the side to be examined, and to flex the leg at the knee (in this position complete relaxation is best obtained); then raise the limb slightly from the bed, supporting it from below with one hand below the knee, and strike the tendon, watching the vastus internus muscle for any contraction which may occur in it.

In comparing the activity of the knee-jerks on opposite sides where the patient is confined to bed, the following method will sometimes be found useful:—The lower limbs being extended and thoroughly relaxed, and the patient lying in the dorsal position, the index-finger of the left hand is placed transversely across the limb just above the knee and in contact with the upper border of the patella. A downward stroke of the hammer on the finger is followed by a contraction of the quadriceps, drawing the patella suddenly upwards. The knee-jerk can only be obtained by this means if it is abnormally active.

In the case of children, a good plan is to take hold of the foot, allowing the sole to rest on the palm of the hand, at the same time slightly dorsiflexing the foot, the leg being flexed at the knee. When the tendon is struck any forward movement of the leg is readily felt by the hand which grasps the foot.

The ulnar aspect of the right hand makes a good percussor in the case of the knee-jerk, although some form of percussion hammer is better.

It is very important in testing the knee-jerk to look for the contraction in the vastus internus muscle. As has been already stated, the leg is only the lever which expresses the contraction in the muscle. Where the patient is wearing boots, or in the case of stout people (where the lever is a heavy one), there may be no movement of the leg, although there is a fairly good contraction of the muscle.

Knee clonus is to be tested for by suddenly depressing the patella tendon, when a series of clonic movements occur.

The knee-jerk is constantly present in health, and is equally active on the two sides. Considerable variations in its activity are to be found in different individuals.

Absence of the knee-jerk is always indicative of organic disease; it is never absent in a purely functional disorder. The alterations which it undergoes under various conditions have been already stated (p. 549). Knee clonus, like ankle clonus, is almost always a sign of organic disease.

A crossed knee-jerk is very occasionally met with; it may be a true reflex; its time reaction is several times as long as the uncrossed.

Adductor-jerk (L. 4 [?]).—This is best elicited by abducting the thigh and tapping the tendon of the adductor-magnus or the internal condyle of the femur. A contraction of the adductors results.

This jerk is only present in a minority of healthy individuals, but can usually be obtained when the other tendon-jerks in the lower extremities are increased.

The crossed adductor-jerk, like the crossed knee-jerk, is probably a true reflex.

Tendo Achillis-jerk (L. 5-S. 1).—The patient kneels on a chair, and the tendo Achillis is struck with the hammer just above its insertion. A

sudden plantar movement of the foot follows the stroke on the tendon.

If the patient is confined to bed, ask him to turn on the side to be examined and to flex the knee, allowing the limb to rest on its outer side on the bed. Take hold of the toes in the fingers of one hand and with the hammer tap the side of the tendon.

Ankle clonus (L. 5-S. 1) is best obtained by flexing the limb at the knee, and suddenly dorsiflexing the foot; when the pressure against the sole is maintained a clonus is set up in the calf-muscles.

Where the clonus is well marked it continues so long as the pressure is maintained (persistent clonus); it may cease, however, after a few movements (imperfect ankle clonus).

The Achillis-jerk is constantly present in health in children, and adults up to fifty years of age. Its absence affords definite evidence of organic disease, for it is never lost as a result of hysteria or functional conditions.

Absence of the Achillis-jerk is of especial importance for diagnosis in cases where the knee-jerk is unaltered. Thus in some cases of tabes, and occasionally in peripheral neuritis, it may be lost while the knee-jerks are still present. After syphilis it is sometimes absent, the knee-jerk being normal, and it is usually absent on the affected side in a case of sciatic neuritis.

True ankle clonus is never present in health. It has been stated by some authorities that it never occurs in hysteria. Although it is true that the pseudo-clonus of hysteria can often be distinguished from that of organic disease, the fact remains that in some cases in which everything points to functional disease alone an ankle clonus occurs which it is impossible to differentiate from that of organic disease. The pseudo-clonus of hysteria is commonly more irregular and often faster than that of true clonus. Dr. Charles Beevor points out that in cases of false clonus, if the foot is very slowly dorsiflexed, before it reaches the point of maximum dorsiflexion, a plantar movement of the foot on the part of the patient usually starts a clonus, whereas in true clonus a sudden movement of dorsiflexion on the part of the observer is necessary to produce it.

Teneriffe. *See* THERAPEUTICS, HEALTH RESORTS (*Islands of South Atlantic*).

Tenesmus.—Painful straining at stool, with the passage of small motions. *See* DYSENTERY (*Symptoms*).

Tennis Arm or Elbow.—Pain in the elbow-joint due to rupture of muscular fibres occurring during the playing of lawn-tennis.

Teno-.—In compound words *teno-* (Gr. τένων, a sinew) means relating to a tendon; e.g. *tenodynia* (pain in a tendon), *tenontitis* or *tenositis* (inflammation of a tendon), *tenorrhaphy* or *teno-suture* (stitching together the divided ends of a tendon), and *tenophyte* (a bony or cartilaginous growth on a tendon).

Tenonitis Anterior.—Inflammation of Tenon's capsule of the eye. *See* SCLEROTIC, DISEASES OF (*Episcleritis*).

Tenon's Capsule.—A fibro-elastic membrane covering the eyeball, and separated by a lymph space (*Tenon's space*) from the underlying sclerotic coat.

Tenosynovitis.—Inflammation of a tendon and its sheath. *See* HAND (*tenosynovitis*); MALINGERING (*Tenosynovitis*); URETHRA, DISEASES OF (*Gonorrhœa, Complications*); WRIST JOINT, DISEASES OF (*Tenosynovitis, Pyogenic, Acute, and Serous*).

Tenotomy.—The cutting of tendons, *e.g.* in operations on deformities such as clubfoot. *See* DEFORMITIES (*Clubfoot, Treatment*); OCULAR MUSCLES, AFFECTIONS OF (*Paralysis, Treatment*); STRABISMUS (*Operative Treatment*).

Tension. *See* PHYSIOLOGY, RESPIRATION (*Pressure of Gases in the Blood*); PHYSIOLOGY, CIRCULATION (*Blood Pressure*); PULSE (*Blood Pressure*); CHILDREN, CLINICAL EXAMINATION OF (*Head, Fontanelles, Tension of*).

Tensor.—The name given to such muscles as by their contraction tighten a part or put it on the stretch; *e.g.* the *tensor palati*, the *tensor tarsi*, and the *tensor tympani*. *See* EAR, MIDDLE, CHRONIC NON-SUPPURATIVE DISEASE (*Treatment to Relieve Tension, Section of Tensor Tympani*); PALATE (*Anatomy, Muscles*); TINNITUS AURIUM (*Varieties*).

Tenth Nerve. *See* VAGUS NERVE.

Tentigo Venerea.—Nymphomania. *See* INSANITY, NATURE AND SYMPTOMS (*Insane Defects of Inhibition*).

Tentorium.—The membranous partition between the cerebrum and the cerebellum (Lat. *tendere*, to stretch).

Tents.—Conical bodies made of sponge, sea-tangle, or tupelo, which expand in the presence of moisture and are used to dilate the cervical canal of the uterus, the opening of a fistula, and other narrow passages. *See* GYNÆCOLOGY, DIAGNOSIS IN (*Cervical Dilators, Tents*).

Tepidarium. *See* BALNEOLOGY (*Historical*).

Teplitz. *See* BALNEOLOGY (*Austria*); MINERAL WATERS (*Thermal*).

Teras.—A monstrosity (pl. *terata*). *See* TERATOLOGY.

Teratogenesis.—The formation or development of monstrosities (Gr. τέρας, a monster, and γεννάω, I beget). *See* Teratology (*Causation*).

Teratoid.—Resembling a monstrosity; especially used as the descriptive name of tumours composed of misplaced blastodermic tissues.

Teratology.

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Definition.—Teratology is the science which deals with antenatal malformations and monstrosities (*terata*), and it forms the better-known part of the large subject of Antenatal Pathology. With the other and less known part the author has already dealt ("Intra-Uterine Diseases and Death of the Fœtus," vol. viii. pp. 254–264). Further, certain portions and some aspects of teratology have been considered under other headings, *e.g.* under "Deformities" (vol. ii.), "Heredity" (vol. iv.), "Hermaphroditism" (vol. iv.), "Labour" (vol. v.), "Maternal Impressions" (vol. vi.), "Pregnancy, Multiple" (vol. viii.), and "Spina Bifida" (vol. ix.); and the description of the diseases of several organs and parts of the body has occasionally included references to their malformations (*vide* "Bladder," "Brain," "Cheek," "Chest," "Colon," "Diaphragm," "Ear," "Eyelids," "Generative Organs," "Heart," "Intestines," "Iris," "Mouth," etc.). In this article, therefore, the author deals only with the general principles of teratology, with teratogenesis or the causation of monstrosities, and with such individual types of monstrosity as have not been referred to elsewhere.

General Principles. — Monstrosities and malformations are produced at an earlier date in antenatal life than congenital diseases: the former occur when the new organism is still in the embryonic phase, while the latter arise in the fœtal stage. Teratology, in a word, is embryology in disorder; monstrosities and malformations are the results of disturbances in the normal organogenesis of the individual before birth; there is defective ontogeny; the vital dynamics of the antenatal formative processes are under the influence of morbid agencies.

Teratology being then the pathology of the embryo, it of necessity follows that a knowledge of the physiology of the embryo must precede the inquiry into its pathology, for the physiology of any part of the life of the individual gives a special character to its pathological manifestations. Now the physiology of the embryo differs markedly from, say, the physiology of the fœtus: almost the sole function of the embryo is to form its parts and organs, it is constructive; on the other hand, the fœtus has functions which resemble in the main those which are found after birth, and the chief result of the right performance of the fœtal functions is growth of tissues and organs as distinguished from differentiation of tissues and organs. The physiology of the embryo is embryology, or rather the anatomy and physiology of the embryo are inseparably bound up together in embryology. For the proper understanding of teratology, therefore, it is necessary to have a good working knowledge of embryology. Unfortunately, a good working knowledge of embryology is not at present obtainable: there are, as regards the human embryo at least, many points in its construction over which darkness rests, and there are lacunæ in our information, more especially of the earliest phases of embryogenesis, which cannot yet be filled up. There is little wonder, therefore, that teratology has many vexed questions and many unsettled problems. Since we cannot yet tell precisely how the embryo *forms* in the womb it is not surprising that we cannot understand exactly by what means it is sometimes *malformed*. Such knowledge, however, as we possess is of value, and the reader will do well at this point to peruse or reperuse the article on the Development of "Fœtus and Ovum" (vol. iii.).

The first factor which gives to teratological phenomena some of their most striking and puzzling characters is, therefore, the embryological one: in embryology rightly understood is the solution to many of the problems of teratology. Let us consider one or two instances of this. Not the least striking feature of embryological processes is their complexity: the whole progress of the development of the embryo is from the simple towards the complex, from the general towards the specialised. In this ontogenetic progress, however, the elaboration and specialisation is not continuous, but interrupted. Apparently the framework of the body is not laid down once for all, but is rather constructed in portions, and even in overlapping portions, so to speak. One part of the framework may be replaced in whole or in part by a new substructure, often of a type quite different from that which has preceded it. Readjustment, adaptation, alteration, and variation are processes constantly at work in the life of the human embryo: it is by reorganisation that order is brought out of the seeming chaos of blastodermic activity. Temporary scaffoldings

are, as it were, raised in order that the whole building of the embryonic cosmos may grow up symmetrically and in such a manner as permits of the later introduction of new structural features; and one of the most beautiful adaptations in organogenesis is that by which the materials of these temporary scaffoldings are utilised and worked into the completed organism. Only here and there in the body, as for example in the appendix vermiformis, do we see traces of these scaffoldings which have not been entirely built into the permanent structure. This conception of embryological processes makes it easier to understand teratological phenomena, for many monstrosities are evidently arrested developments: they represent stages in organogenesis which are usually transitory, but which under certain circumstances are rendered permanent. The formation of one part of the body may be arrested while that of the rest of the body goes on to its full completion, and so a malformation of a part may be met with while the other portions of the organism are well constructed. If we could obtain a cinematographic representation of ontogeny then we could recognise when and in what part of the living picture the process of arrestment took place.

A second factor which has to be kept in mind in endeavouring to understand the phenomena of teratology is found in the immediate environment of the embryo during the developmental processes. In the earliest phases the amniotic membrane comes into close contact with the new organism, and later the liquor amnii takes its place and constitutes the embryonic hydrosphere. There is much to show that this amniotic environment plays an important part in determining the nature of the pathological manifestations of embryonic life, and it cannot be doubted that it is instrumental in producing a great many of the arrests which lead to malformations and monstrosities. If there is one thing which experimental teratogenesis has shown, it is that amniotic adhesions and pressure are agents in the disturbance of normal ontogeny.

A third factor is the germinal one. All teratological phenomena do not arise in the embryonic epoch of antenatal life: some are determined already in the germinal period. It is scarcely conceivable that hereditary malformations, and there are many instances of such, can owe their origin to causes coming into play after the laying down of the first rudiments in the embryonic area of the blastoderm: their hereditary nature practically implies that they were determined before that time. Again, there is some reason to believe that double monstrosities arise in the pre-embryonic epoch, and that they are caused by anomalies in the phenomenon of ovum-penetration by the spermatozoa or by disturbances in the extrusion of the polar bodies.

That these three factors, and possibly others, are effective in influencing the production of pathological processes in the embryo is without doubt; that a knowledge of them is of value in understanding these pathological occurrences is also without doubt: but, unfortunately for the successful explanation of teratological phenomena, these factors are themselves little understood. There are many difficulties in embryology: the development of the human amnion is still a mystery; and what happens in the pre-embryonic or germinal period of antenatal existence is concealed by nature's veil. At the same time the information which we possess is of great value, and with each advance in our knowledge of normal embryogenesis will come a surer appreciation of the facts of pathological development. Teratology is the pathology of the embryo as influenced by that of the germ; teratogenesis is morbid embryogenesis.

Causation of Monstrosities (Teratogenesis).—There is scarcely any part of the history of medicine which has a more interesting past than that of the theories of the production of malformations and monstrosities. The modern scientific investigator pauses in dismay and humiliation when he is brought face to face with the teratogenetic theories with which former generations of medical observers were content, and his feelings are little altered when he realises how much of the past is contained in the accepted doctrines of the present day. This article is hardly the place to consider the theories of the past in so far as they refer to teratogenesis; but a very few words may be devoted to the enumeration of two or three of the more noteworthy of them.

Perhaps the best known of these *theories of the past* is that which ascribes the various malformations of the fœtus to the imagination of the mother during pregnancy. This subject has been already considered by the writer ("Maternal Impressions," vol. vi.), and need not be again referred to except to point out that it is far from being discredited by all obstetricians, although of scientific proof it is sadly lacking. Another group of the teratogenic theories of the past contains the supernatural explanations which were given by the ancients to explain malformed infants, and which are still accepted by primitive peoples at present inhabiting various parts of the world. According to some of these views the gods made monstrosities to amuse themselves and to astonish mortals, or to warn the inhabitants of the earth of impending calamities: these ideas are wrapt up etymologically in the words "monster," "freak of nature," "portent," etc. According to other views it was to the evil deities only that men were indebted for the appearance of monstrosities upon the earth; and in Christian times it soon came about that Satan was connected with teratological pheno-

mena, a belief of which abundant traces are to be found in the witchcraft trials of the Middle Ages. According to yet other views monstrosities were caused by peculiar conjunctions of the heavenly bodies, and a whole mass of astrological beliefs arose concerning stellar influence in teratogenesis. The moon also was supposed to have a maleficent effect upon the unborn infant, as is shown by the occurrence of the word "moon-calf" as a synonym for a monster, mole, or false conception.

A third group of the theories of the past looked to purely physical agencies for the causes of monstrous births. In those early times it was thought that the male semen and the menstrual fluid of the mother together made up the new organism. Consequently it was a natural enough conclusion that defects in the male and female generative elements would result in the production of malformations and monstrosities. The teratological manifestations which showed defective formations, such as brainless infants and fœtuses without eyes or limbs, were put down naturally enough to too little semen or too little menstrual discharge, while the double monsters and united twins were ascribed to too much. Other developments followed: it was believed that the admixture of the generative elements in abnormal proportions or in morbid states would prove teratogenic; and, finally, it was accepted that the mixture of the seed of animals of different species would assuredly lead to the birth of all kinds of grotesque and unnatural hybrid forms. Had the ancients, *e.g.* Aristotle, possessed more correct notions of the real nature of impregnation it cannot be doubted that their theories of teratogenesis would not have differed so markedly from those now in vogue as they apparently do: indeed, some modern views do not really differ much from the notions of too much and too little semen which were enunciated so long ago.

The *teratogenetic theories of the present* may be divided into three groups according as the causal factor invoked is mechanical, pathological, or embryological. It is necessary to devote a few lines to the consideration of each of these groups.

The idea that fœtal deformities may be due to *mechanical causes*, although truly modern in its full development, was present in the mind of Hippocrates when he wrote, in his *De Genitura*, about infants crippled in the womb on account of narrowness of a part of it; and Aristotle had evidently some notion of it when he explained double monsters in animals by the fusion of two contiguous vitelli. Many centuries later Paré also referred to malformations produced by the straitness of the womb, and evidently thought that external pressure applied to the abdomen might likewise have a teratogenic effect. In modern times these theories appear under new names, but differ little in reality, and they may be grouped as follows:—

Mechanical or Pressure Theories of Teratogenesis.—1. External pressure. (*a*) General maternal traumatism, *e.g.* falls and blows. (*b*) Injuries and pressure affecting the maternal abdomen, *e.g.* corsets. 2. Internal pressure. (*a*) Intra-abdominal, *e.g.* from abdominal tumours, pelvic contraction, and narrowness or malformation of the uterus. (*b*) Intrauterine, *e.g.* from uterine tumours, a twin fœtus, a fœtal limb, the umbilical cord, the amnion or amniotic adhesions.

In the minds of most teratologists there may exist some doubt about the teratogenic power of external pressure, but internal pressure of the kinds referred to in the above classification is generally accepted, rightly or wrongly, as a potent agent in producing monstrosities. Coiling of the umbilical cord round one or several limbs of the fœtus has been freely accepted as a cause of the curious spontaneous amputations which are sometimes seen at birth; it is certainly often associated with the occurrence of grooves and sulci on the limbs and digits. The most popular of the pressure theories of the present day is that which looks to the amnion as the immediate cause of monstrous productions. Experiments in comparative teratogenesis by Dareste and others have shown that in the case of the chick, at least, non-development of the amnion very often exists along with various monstrosities; and in anencephaly and sympodia, for instance, it is a satisfactory hypothesis to regard the malformations of the head and pelvis as caused by non-separation of the amniotic membrane in these regions. By inference the non-separation will cause pressure on the underlying part. As will be seen later, this view takes its place in the embryological theory of origin of monstrosities.

The second modern theory may be called the *pathological*, for it looks to diseases of the fœtus for the causal factor in teratogenesis. This idea was first strongly advocated by Marcot and Morgagni in the eighteenth century, although indications of it are to be found in the work of Licetus published in the preceding century. The various forms of defective ossification of the bones of the head were ascribed to inflammatory conditions of the cerebral ventricles which led to hydrocephalic states, and these in their turn to defects in the cranium; when the hydrocephalus was very great, rupture of the cranial vault might occur, and thus anencephaly be produced. In a similar way exomphalos was supposed to be due to the accumulation of a large quantity of fluid in the abdomen and the giving way of the anterior abdominal wall; spina bifida by an accumulation of cerebro-spinal fluid in the spinal canal; cyclopia from the dropsical destruction of the bones of the nose;

extroversio vesicæ by the over-distension of the urinary bladder; and intestinal malformations by fœtal peritonitis. It cannot be said that this manner of looking upon teratological productions is in keeping with the most recent view of embryology and ontogenesis; for it is well known that the time when monstrosities are produced antedates that when diseases arise; and, therefore, it can hardly be maintained that the fœtal diseases are the causes of the embryonic malformations. At the same time it cannot be doubted that diseases coming on in fœtal life may have their manifestations altered by pre-existing malformations, and that, conversely, pre-existing malformations may be modified by later-developed maladies. To this extent there is evidence in support of the pathological theory of teratogenesis.

The third of the modern theories of teratogenesis may be termed the *embryological*, for it finds in an interference with the normal processes of embryogenesis the true explanation of teratological developments. Its distinguishing feature is the assertion that monstrosities are due, not to special causes, but to the causes of disease acting upon the embryonic organism. It is not that fœtal diseases give rise to monstrosities; it is that the causes of fœtal as well as adult diseases give rise, when acting upon the embryo, to embryonic malformations, and the embryonic malformations are the monstrosities. The proof of this conclusion lies mainly in the experimental work of Dareste and Féré, who have shown that by altering the incubation conditions it is possible artificially to produce deformed chicks. Féré, further, has demonstrated that by injecting toxic substances, germs, and toxines into the albumen of the hen's egg in the early stages of development, it is possible to cause maldevelopments and non-developments; that is to say, by bringing the ordinary causes of adult disease to bear upon the embryonic organism, monstrosities and not diseases result. The same thing has been shown with regard to many of the invertebrates, but the experiments upon the chick are naturally of more value in enabling us to draw conclusions regarding the human embryo. At the same time it is necessary to remember that it is not safe to expect that the details in the production of mammalian malformations will be the same as those which come into play in the origin of avian monstrosities: avian and mammalian embryology differ, and it is reasonable to expect that avian and mammalian teratogenesis will also differ, not perhaps in general principles, but certainly in details. It is particularly interesting to note that experiment has shown that just as the alcohols and aldehydes differ in their toxic powers, so also they vary in their teratogenic potency; further, the more toxic the alcohol is, the more capable it appears to be of producing monstrosities in the chick. This theory of teratogenesis receives a certain measure of support from the clinical histories of the parents of monstrous infants, for it is not uncommon to find that the mother (or the father) has been a sufferer from tubercle, syphilis, alcoholism, an eruptive fever, or lead-poisoning during or before the pregnancy: the conclusion is that the poison or toxine has interfered with the normal processes of development.

The manner in which the toxine, germ, or poison acts upon the embryo has not yet been fully ascertained; but some conclusions seem fairly to be warranted. It would seem, for instance, that the morbid cause very often acts by arresting normal embryogenesis. When the arrest is complete, the result is a non-development; when it is partial, one organ or part of the body alone shows delay, the rest of the organism goes on developing around it, and the result is a monster. In this way most of the monstrosities by defect are probably produced. With regard to the double monsters (united twins) and monstrosities by excess, it would seem that the morbid agency comes into play at an earlier than the embryonic period: it is a fairly probable hypothesis that it alters the chemistry of the ovum, or its immediate environment, and thus permits the passage of two spermatozoa through the vitelline membrane. Polyspermy thus produced would then be the cause of the development of two embryonic areas, and according as these lay separate or in contact, and were complete or incomplete, there would result normal twins or double monsters, or monsters by excess (accessory limbs, parasitic fœtuses, etc.). Another teratogenetic method would seem to be that by inclusion ("*enclavement*"), by which it is meant that a whole fœtus (more or less defective) is included within its twin brother or sister, or that in the case of a single fœtus a part of its ectoderm becomes displaced inwards, and lies and undergoes some further development among the ectodermal and mesodermal tissues. Now and again, also, it would seem as if embryological phases which are normal in the development of certain animals, but which do not, as a rule, show themselves in human organogenesis, appear in the latter, and so lead to atavic manifestations. Of course, it must be borne in mind that there is much obscurity in all these matters, and that many of the statements which are to be found in works on teratology are really hypothetical.

It is safe to conclude that malformations and monstrosities, as a rule, represent faults in nutrition induced by one or other of the recognised causes of disease. Nutrition in the embryonic period of life results, of course, in development rather than in growth, and consequently defective nutrition will then interfere with development and produce maldevelopment. There will be an arrest of the formative pro-

cesses in whole or more commonly in part,—structures which ought to appear will not do so, structures which ought to unite will remain separate, phases which ought to be temporary will be permanent,—and so various malformations and monstrosities will be produced. It is comparatively easy, further, to understand how defective development of the amnion will, by preventing the peripheral expansion of the underlying parts, lead to many of the well-known teratological manifestations, such as anencephaly, sympodia, exomphalos, etc.

Classification.—Hitherto teratological classifications have often been rather a hindrance than a help to the understanding of the subject. There have been many of them, the names employed in them have been polysyllabic and unfamiliar, and different teratologists have employed very different methods with widely different results. One of the simplest, as it is also one of the oldest, methods of classification is to divide all monstrosities into those by excess, those by defect, and those in which there is altered relation of parts. After all that has of late years been discovered, this method has still much to recommend it. The method adopted by the writer (in *Teratologia*) is a modification of that used by the late Professor Taruffi of Bologna, and aims at being both simple and yet sufficiently comprehensive to find a place for all known malformations. By it monstrosities are divided into two primary divisions according as they represent two fœtuses or only one, the polysomatous and the monosomatous terata. The monosomatous terata, again, are subdivided into those in which the whole body or at least several parts of it are malformed, and those in which only one part or region is deformed; for the latter a strictly regional classification is adopted. Finally, a separate place is found for the curious cases of inversion of the viscera or heterotaxy. In an abridged form the scheme is as follows:—

A. Polysomatous Terata—
  1. Monochorionic or uniovular twins.
  2. Allantoido-angiopagous twins or placental parasites.
  3. United twins or double terata proper.
    (*a*) Symmetrically united.
      (1) Syncephalus.
      (2) Dicephalus.
      (3) Thoracopagus.
    (*b*) Asymmetrically united or parasitic twins.
  4. Triplets, etc.

B. Monosomatous Terata—
  1. Whole body (or several parts of it) malformed (pantosomatous).
  2. Parts of the body malformed (merosomatous).
    (*a*) Head.
    (*b*) Neck.
    (*c*) Thorax.
    (*d*) Abdomen and pelvis.
    (*e*) Spine.
    (*f*) Limbs.
  3. Heterotaxy or transposition of the viscera.

In this classification the first section roughly corresponds to the monstrosities "by excess" of the older schemes, while the second includes the malformations "by defect" and by "altered relations."

Types of Terata.—As it is impossible within the limits of an article such as this to describe or indeed name all the varieties of teratological development which may be met with, the writer contents himself with referring to the outstanding types.

Types of Polysomatous Terata.—Since monochorionic or uniovular twins have been already considered under another heading (Pregnancy), and since some hesitation may be felt regarding the wisdom of terming this variety of twins teratological, the writer passes at once to the consideration of the placental parasites about whose teratological nature there can be no possibility of doubt.

Placental Parasites or allantoido-angiopagous twins.—These are twins of the same sex enclosed within a single chorion, one of which shows more or less grave developmental defects, and communicates with the other by means of the vessels of the umbilical cord in the neighbourhood of the placenta. The usual clinical history in such cases is that the pregnancy terminated somewhat prematurely in the birth of a normal fœtus, but that before or along with the expulsion of the placenta a deformed twin was born; the placenta was single, and gave origin to two umbilical cords whose vessels inosculated in the substance of the afterbirth. The deformed twin may show a great variety of defects, among which absence of the heart is not uncommon; indeed, such fœtuses may be divided into the acardiac and the cardiac varieties. But a more useful classification is to group them into (1) those in which the head, trunk, and lower limbs are present, but the head is deformed, and the upper limbs very rudimentary (*paracephalic*); (2) those in which the head is entirely absent, and in which the trunk and upper limbs are very defective (*acephalic*); and (3) those in which the external appearances of a fœtus are lost, and a rounded mass with slight indications of limbs and sense organs is all that is to be seen (*amorphic, anidean*). The internal malformations are of the most varied type; sometimes almost all the viscera are present, but in a more or less anomalous state; at other times scarcely a single part may be found, and the fœtus be represented by some fragments of bone, a loop or two of intestine, much œdematous adipose tissue, and skin. Most of these curious monstrosities are quite incapable of existence after birth; indeed the fact that they are able to reach the end of

intra-uterine life is due to the communication existing between their umbilical vessels and those of the normal twin. The theories which have been advanced to explain their origin are not satisfactory. The more generally accepted view is that of Claudius as modified by Ahlfeld, according to which the twins are uniovular, and one gets the start of the other in development, and preoccupies all the available chorionic space with its vessels, so that no room is left for the vessels of the second, which in consequence becomes a parasite on the first, and has its embryogenetic processes much retarded. Another theory is that there is a primary defect of development of one of the twins, so great that if it were not for the fact that it establishes a connection with the placenta of its co-twin, it would never be able to develop even so far as it does. The writer inclines to the second view. There seems to be no doubt that the circulation is reversed in the malformed twin, and that the heart of the normal fœtus usually does double duty in driving the blood through both twins.

United Twins or Double Monsters.—Most of the polysomatous terata belong to this group. Some of them are quite evidently double, two complete fœtuses being united together by a more or less broad band of connection; in others the duplicity apparently affects only a part of monstrosity, as in the cases of a single head and two bodies, or a single body and two heads: in both these groups of terata the union is practically *symmetrical*. In another variety, however, the union is *asymmetrical*, there being one fairly well-formed twin with a more or less rudimentary one attached to its body or embedded in its substance: the former fœtus is called the autosite, and the latter the parasite.

Syncephalic Double Terata.—The first group of the symmetrically united twins contains those in which the cephalic ends are more or less closely joined, while the bodies are more or less separate. There are, for instance, the cases in which two well-formed twins are joined by their crania (craniopagus); sometimes the union is in the region of the vertex, sometimes in that of the forehead, and sometimes in that of the occiput. The general rule is followed, that like parts are joined to like. The union in such cases is sometimes relatively superficial: the cranial vault-bones may be fused, but the brains are usually separate. Again, there are the cases of syncephalus, in which the two heads are more or less intimately fused together, and in which there may be two complete faces or two incomplete faces (two mouths, two noses, three orbits, and two ears). To these the name of Janus monstrosity is not uncommonly given, for a reason which is evident. The thoraces may be also more or less fused together. When there are two complete faces, each face may represent, not that of one twin, but the halves of the two belonging to the two twins, which are so perfectly joined as to show no sign of original separation. Yet again, there are those syncephalic double monsters in which the fusion of the heads and bodies is so complete that only in the pelvic organs and lower limbs is duplicity evident (syncephalus dilecanus): these are very rare in the human subject, being represented chiefly by the cases of diphallus (double penis).

Dicephalic Double Terata.—In the second group of the symmetrically united twins the union chiefly involves the pelvic ends of the fœtuses. Here also there are different grades of union. There are, for instance, the cases in which the pelves are closely joined and the four lower limbs retained (pygopagus and ischiopagus); there are those in which not only the pelves, but also parts of the trunks, are united with four, three, or two lower limbs, and four, three, or two upper limbs; and there are those in which there is such a degree of fusion that only the heads and sometimes also the necks show duplicity, the body and limbs being those apparently of one fœtus.

Thoracopagous Double Terata.—To this section belong some of the best-known examples of united twins, such as the Siamese twin-brothers, the sisters Radica-Doodica (operated on by Doyen), and the sisters Maria-Rosalina of Brazil (operated on by Chapot-Prévost). The union is by means of a more or less extensive part of the anterior aspect of the thoraces and abdomens. The name xiphopagus may be reserved for those which are joined by the epigastric region and by the lower end of the sternums, while that of sternopagus may be given to those in which the whole of the sternal and epigastric areas are fused. In the latter group it would seem that one of the twins always shows inversion of the viscera, and that sometimes the two hearts are separate and sometimes more or less closely united. In both groups it is common to find a prolongation of the peritoneal sacs, and sometimes a band of liver tissue in the structure connecting the two twins. The stomach and part of the intestinal canal may be single, but often the alimentary tract is double throughout. There is usually a single umbilical cord. In a rare type of sternopagus the union is more marked, with the result that the two contiguous arms are fused into one limb, which may show signs of its double origin (*e.g.* two hands or more than five fingers); when this is so the single median limb springs from the posterior aspect of the united thoraces. In a still rarer type the two contiguous limbs may be entirely aborted and the monstrosity be provided only with two upper extremities. Many interesting physiological observations have been made on united twins of the thoracopagous type, for in not a few cases these children have survived birth; it has been generally found that while they show a very considerable similarity in tastes, feelings, etc., their chief bodily

functions exhibit marked independence. The surgical possibilities of these cases will be considered in a special paragraph at the end of this article.

Parasitic Twins.—The last group of the polysomatous terata contains the cases in which one well-formed twin has attached to it or embedded in it another twin, usually of a very rudimentary type. These monstrosities may be classified after a regional plan into (1) those in which the parasite is attached to or embedded in the head of the autosite, cephalo-parasites; (2) those in which the union is in the neighbourhood of the face or neck, prosopo- and trachelo-parasites; (3) those in which it is in the region of the thorax, thoraco-parasites; (4) those in which the parasite is abdominal in position, gastro-parasites; and (5) those in which it is pelvic, lecano-parasites. In each of these divisions there are subdivisions, according as the parasite consists of a more or less recognisable fœtus, or only of a mass of miscellaneous fœtal tissues (teratomata, teratoids, dermoids). Included among these monstrosities, therefore, are to be met the instances of epignathus (rudimentary fœtus attached to the mouth), of heteradelphus (headless fœtus attached to the front of the thorax, such as the well-known boy Laloo), of included fœtus or fœtus in fœtu (fœtus or teratoma contained in the abdominal cavity), and of sacral parasites and tripod fœtuses (more or less defective fœtuses attached to the pelvic bones of the autosite). Many of these are quite non-viable, but some others are not incompetent for a post-natal life, and have even survived to adult life (*e.g.* the man Dos Santos, the human tripod). In a few instances surgical separation or excision of the parasite has been attempted, but seldom with success.

Triple Monsters.—It is hardly necessary to do more than name triple terata here, for they are exceedingly rare. A case of tricephalic infant was reported in the year 1834: it consisted of three heads set upon two united trunks, supported by two lower limbs; there were three upper limbs and a single set of male genitals; all the heads had to be perforated in labour, and two of them amputated. It was described fully by Reina of Catania and Galvagni.

Types of Monosomatous Terata.—So numerous are the types of single monsters and malformations that only the outstanding ones can be referred to here. Some of them, such as exstrophy of the bladder, encephalocele, diaphragmatic hernia, polydactylism, anencephaly, exomphalos, spina bifida, cleft palate, hare-lip, etc., have been described under other headings.

Malformations of the Cranium and Face.—Putting on one side the anomalies of the cranial vault, of the face, of the brain, and of the special sense organs, which have been considered elsewhere, the writer must give a few words of description here to cyclops and hypoagnathy. The *cyclops* fœtus is, as the name indicates, one possessed of a single orbital cavity containing two more or less completely fused eyeballs. The composite eye is median in position, and a nasal proboscis is usually found lying above it (very rarely below it). The malformation known as cebocephalus is evidently a connecting link between the true cyclopean fœtus and the normal, for in it there is no nose and the two eyes are approximated but not fused. Cyclops may be combined with other malformations (*e.g.* anencephaly, hypoagnathus) in the same fœtus. The single eyeball may possess two corneæ, two pupils, and two lenses; or it may be an apparently perfect single eye; or it may show intermediate types. Sometimes a single orbital cavity with no trace of an eye has been observed. Cyclops is supposed to be due to an arrest in the development of the anterior cerebral vesicle, but there are many obscure points in its teratogenesis still to be investigated. A somewhat similar monstrosity is *hypoagnathus* (also called otocephaly, agnathy, and synotia); in it the lower jaw is more or less completely absent, and the external ears are approximated towards each other under the lower part of the face. The mouth may be absent or represented only by a small aperture; the tongue and hyoid bone may be absent or rudimentary; the sphenoid bone may be malformed; and the external auditory meatuses may open directly into the pharynx. As stated, it may be combined with the cyclopean anomaly. It is due to an arrested development of the first branchial arches, perhaps on account of amniotic pressure. Sometimes in the region of the face there is no trace of eyes, nose, or mouth; the monstrosity is then called *aprosopus*.

Malformations of the Spine.—In addition to the well-known spina bifida (evident or occult) this region of the body may show the curious deformity of *retroflexion*. The whole body of the fœtus may be bent sharply back upon itself, so that the occipital region of the skull may come into contact with the gluteal region, and even become united to it, so that the glutei muscles may, as it were, arise from the occiput. This retroflexion of the fœtus is often combined with defective development of the lower part of the occipital bone, when the name *iniencephaly* is sometimes given to it; it may also be combined with anencephaly, and sometimes with exomphalos. It is possibly an arrested development, for it would seem that there is a stage in early embryogenesis when the spine is thus contorted; perhaps here also amniotic pressure may be invoked. *Tailed infants* have been described; the "tail" is usually a modified spina bifida sac (*see* "Homo Caudatus").

Malformations of the Thorax and Contents.—In addition to polymastia (presence of supernumerary mammæ), fissure and lordosis of the

sternum, absence of the pectoral muscles, and the congenital malformations of the heart and vessels, attention must be drawn to the rare cases of *ectopia cordis* and to absence of the clavicles. When there is exomphalos it is not uncommon to find that the defect in the anterior abdominal wall affects also the thorax, and that the heart is extra-thoracic; but it is much rarer to find an open state of the anterior thoracic wall alone with protrusion of the heart. It is apparently a commoner malformation among birds than in the human subject. The parietal layer of the pericardium may be absent. Infants born with this malformation usually survive only a few hours. *Absence of the clavicle* may be unilateral or bilateral, and it may be complete or partial; this also is a very rare deformity, but unlike ectopia cordis it is quite compatible with post-natal existence.

Malformations of the Abdomen and Contents.—Most of the malformations of the abdomen have been described under other headings. They include the various types of exomphalos, of ectopia vesicæ, of horseshoe kidney, and of intestinal anomalies. It may be noted that while defects in the anterior abdominal wall with protrusion of the viscera are commonly mesial in position, they may occasionally be lateral, and are then sometimes accompanied by absence of the lower limb of the same side. Many cases of exomphalos are complicated by the presence of amniotic adhesions, and by retroflexion of the spinal column. Malformations of the liver, gall-bladder, spleen, pancreas, etc., occur, but have not been very fully studied. Anomalies of the generative organs have been described elsewhere.

Malformations of the Limbs.—Sympodia is a malformation of the lower limbs which calls for a few lines of description. It consists in a rotation of the lower limbs of such a kind that the knees look backward and the popliteal spaces forwards, combined with a varying degree of fusion of the contiguous parts. The resulting monstrosity has been called sireniform or mermaid-like. There is usually absence of the generative organs and a curious fusion and rotation of the bones of the pelvis; the bladder and kidneys are also commonly wanting. There is generally only one artery in the umbilical cord, and it has been supposed that in these cases the allantoidal vessels as well as the allantoic derivatives are absent, and that the vessels in the cord represent the omphalo-mesenteric or vitelline vessels; if this be so it would appear that the placenta must be vascularised by the vitelline and not by the allantoidal vessels. More or less complete suppression of one or more of the upper and lower limbs may be met with, and constitute amely, hemimely, and ectromely; along with these may be placed the so-called spontaneous amputations of limbs, parts of limbs, and of digits. Other malformations of the extremities consist in absence of one or other of the two bones of the forearm and leg, anomalies which are usually associated with suppression of the corresponding digits. A few cases of double hand have been reported, in which the radius was absent and two ulnæ found in its place.

Heterotaxy or Transposition of the Viscera.—Under the name of transposition or inversion of the viscera is described an interesting anomaly, in which the organs of the right side of the body are found occupying the left side, and *vice versa*. When the abdomen and thorax are opened it is as if the observer were surveying the parts as reflected in a mirror. The heart is on the right side, the liver on the left, etc. Even in the matter of small peculiarities, as seen in the level of organs and the direction of vessels, the transposition is accurate and complete. Rarely the thoracic organs alone are transposed. The anomaly in no way interferes with life, and is usually discovered accidentally when the individual is being examined for some abdominal or chest complaint, or for life assurance, or the army. The cause of heterotaxy has been supposed to be the position which the embryo occupies on the blastodermic vesicle; it usually lies on its left side, and has the cardiac curvature normally directed, but if it be rotated so as to lie on the right side there is inversion of the heart. Some have believed that an individual with inversion of the viscera is the right-side survivor of uniovular twins, but if so the other twin would appear to have been completely absorbed. The puzzling cases of hemi-hypertrophy and hemiatrophy may be associated in their origin with the causes that produce heterotaxy. The functions of the body are sometimes curiously affected in transposition; thus a case has been reported of labour in a woman with this anomaly, in which the fœtal head occupied the right instead of the left occipito-anterior position.

Treatment.—There are three lines along which the treatment of monstrosities may proceed: an attempt may be made to prevent their occurrence; it will be necessary to endeavour to counteract any injurious effect they may have upon the progress and safety of the confinement which they render complicated; and means ought sometimes to be taken to repair the malformations and fit the subjects of them for a useful and happy life. The second line of treatment, which may be termed the *obstetrical*, need not be referred to here, for it has already been considered under another heading ("Labour, Faults in the Passenger"). With regard to the *preventive* treatment, it cannot be claimed that much of practical importance has been yet accomplished; but if it be correct to suppose that the causes of monstrosities are no other than the causes of disease, then it follows that if the action of these upon

the unborn child can be prevented the malformations and anomalies produced by them will be eliminated. The most hopeful line of possible advance in this matter will be that of treating syphilis and alcoholism in the parents before and during the progress of gestation; the shielding of pregnant women from infection of all kinds will also be a logical procedure.

Surgical Management.—The management of malformations and monstrosities after birth in the infants which survive their advent in extra-uterine surroundings has, of course, always engaged the attention of the medical man, and more especially of the surgeon. It is unnecessary in this article to describe the various operative procedures which have been devised to remedy in the most effective manner such anomalies as hare-lip, cleft palate, exstrophy of the bladder, exomphalos, encephalocele, and defective states of the limbs, for these have been dealt with by competent surgical writers, but a few lines may be devoted to the question of the propriety of operating upon united twins, a matter which has quite recently come somewhat prominently before the medical world. Attempts to separate united twins are not altogether novelties in surgical procedure. As long ago as 1690 Koenig reported a case in which the connecting band (which contained no liver tissue) between the twins was divided, and both children survived; in a similar case operated on by Boehm (1860) one child only lived. In the instance described by Biaudet and Bugnion (1881) there was a bridge of hepatic tissue, and both twins died from hæmorrhage from the liver and sepsis. Until the beginning of the present century it cannot be said that the new resources of surgery (asepsis and perfected hæmostasis) had ever been brought into operation to enable the surgeon to overcome the undoubted difficulties and dangers of the disjunction of double monsters. Now, however, that these means are in our hands, and that Chapot-Prévost and Doyen have led the way, it will be necessary for us to revise our ideas of the feasibility of operating upon such united children, and to formulate the indications for surgical interference. There are some cases in which the fusion of the two organisms is so intimate as to preclude any hope of successful separation, *e.g.* all the syncephalic types except perhaps some of the craniopagous twins, and most of the dicephalic with the exception of some of the pygopagous varieties; on the other hand, there seems no reason why attempts to separate most of the thoracopagous double terata should not be hopefully entertained. The cases operated on by Chapot-Prévost and Doyen were both of the last-named kind. In 1900 Chapot-Prévost of Brazil separated Maria-Rosalina, then at the age of seven years: he devised a special form of operating-table, which could be divided into two halves after the separation of the twins was effected, and a special means of arresting hæmorrhage from the liver, for a bridge of liver tissue was known to exist; one twin (Rosalina) survived, the other (Maria) died about a week after the operation from pleuro-pericarditis. Rosalina, it may be noted, showed transposition of the viscera (dextro-cardia). Doyen operated upon Radica-Doodica, because the Doodica had shown symptoms of abdominal tuberculosis; Radica survived. It is therefore evident that the technical difficulties of separating united twins can sometimes be overcome; but it cannot be said that surgeons have yet agreed as to the proper cases upon which to operate or as to the best means and methods to employ.

Teratoma.—A congenital tumour containing tissues belonging to different layers of the blastoderm, *e.g.* teeth, hair, bone, nerve tissue, etc., and occurring in a position where these structures do not normally occur, *e.g.* a dermoid tumour in an ovary. *See* LIVER, DISEASES OF (*Lipoma and Teratoma*).

Teratoscopy.—The foretelling of the future by means of a consideration of the characters of malformed and monstrous infants.

Terebenum.—Terebene is a mixture of hydrocarbons obtained from the oil of turpentine; it has the odour of pine-wood, and, given internally in doses of 5 to 15 m. (on sugar), is used as an expectorant in chronic bronchitis; it may also be inhaled. *See* EXPECTORANTS.

Terebinthina Canadensis.—Canada balsam is the oleo-resin of *Abies balsamea*; on account of its property of drying to form a transparent varnish it is used in the preparation of collodium flexile (*q.v.*).

Terebinthinæ Oleum. *See* TURPENTINE.

Teres.—Round; used especially as a term, in descriptive Anatomy, for rounded muscles and ligaments (*e.g.* the teres major muscle and the ligamentum teres of the hip-joint or of the uterus).

Terpenes.—Hydrocarbons with the chemical formula $C_{10}H_{16}$. *See* TURPENTINE.

Terperoin.—A combination of terpene hydrate ($\frac{1}{2}$ gr.) and heroine hydrochloride ($\frac{1}{50}$ gr.) made up with syrup of pine or glycerine base (*Squire*), and recommended in chronic bronchitis with much cough, in asthma, emphysema, etc.

Terpinol.—An oleaginous liquid, soluble in alcohol, recommended as a stimulating expectorant in doses of 3 to 10 minims.

Terrors. *See* NIGHT TERRORS (*Pavor Nocturnus*) and *Cross References.*

Tertian.—A term used in describing a fever

which recurs every other day (Lat. *tertius*, third); *e.g.* tertian ague, or one in which the intervals last about 48 hours. *See* MALARIA (*Clinical Manifestations, Benign Tertian*).

Tertiary.—A term used specially for those manifestations of syphilis which appear third in order of time. *See* SYPHILIS (*Tertiary*).

Tertipara.—A woman who is being confined for the third child; one who has had two previous labours.

Tesla Currents.—Rapidly alternating high tension currents of electricity; d'Arsonval currents. *See* X-RAYS (*High Frequency Currents*).

Test. *See* ALCOHOL (*Tests*); ASEPTIC TREATMENT OF WOUNDS (*Evidences of Asepticity*); AUDITORY NERVE AND LABYRINTH (*Physiology, Weber's and Rinne's Tests*); DIGESTION AND METABOLISM (*Examination of Gastric Contents, Test Meals*); EYE, CLINICAL EXAMINATION OF (*Visual Acuity, Test Types*); GLYCOSURIA (*Detection*); TOXICOLOGY (*Tests for Poisons*); URINE, PATHOLOGICAL CHANGES IN (*Tests for Sugar, Albumen*, etc.).

Testalgia.—Neuralgia of the testis. *See* SCROTUM AND TESTICLE, DISEASES OF THE (*Testalgia*).

Testamentary Capacity. *See* LUNACY (*Duties of Medical Men, Will-Making*).

Testectomy.—Removal of the testicle. *See* SCROTUM AND TESTICLE, DISEASES OF THE (*Tumours, Castration*).

Testes.—The plural of *testis*. *See* SCROTUM AND TESTICLE, DISEASES OF THE.

Testicle. *See* SCROTUM AND TESTICLE, DISEASES OF. *See also* ABDOMINAL ANEURYSM (*Symptoms, Pain in the Testicle*); HYSTERIA (*Hyperæsthesia, Testicular Area*); LEPROSY (*Lepra Tubercles*); SYPHILIS (*In Children, Later Symptoms, Testes*); TABES DORSALIS (*Symptomatology, Genital Organs*); TUBERCULOSIS (*Epididymis and Testis*); VISCERAL PAIN (*Sensory Supply of the Testicle*).

Testicular.—Belonging to the testicle; e.g. *testicular artery* (spermatic artery), *testicular cord* (spermatic cord), and *testicular duct* (vas deferens).

Testis. *See* TESTICLE.

Testitis.—Inflammation of the testicle; the more common form is *orchitis*.

Tetanic or Tetaniform.—Of the nature of tetanus (*q.v.*); resembling tetanus.

Tetanilla.—Tetany; paramyoclonus multiplex. *See* TETANY.

Tetanus.

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TETANUS (lockjaw; tétanos, Starrkrampf) is an acute specific infective disease, characterised by involuntary tonic muscular spasms, tending to become generalised, and with paroxysmal exacerbations from time to time. The specific micro-organism, the tetanus bacillus, having gained entrance to the body, elaborates a toxin of great potency, which, acting on the motor cells of the spinal cord and medulla oblongata, increases their irritability, and thereby induces the spasms. The disease is exceedingly dangerous, and not infrequently fatal.

The disease had been recognised by Hippocrates, Galen, and Celsus. Its infective character had long been recognised, and many observers, noticing the manner in which the symptoms resembled those of strychnine poisoning, had suspected that the disease was caused by a poison. But the infective nature of the disease was first definitely established by Carle and Rattone in 1884. In the same year Nicolaier discovered the tetanus bacillus in garden soil. Rosenbach in 1886 found the bacillus in the wound in a case of tetanus of the human subject. Nocard, in the following year, demonstrated the bacillus in the pus from a horse affected with the disease; and Kitasato, in 1889, was the first to obtain a pure culture of the bacillus, and to prove that the subcutaneous inoculation of animals therewith causes tetanus.

Tetanus bacilli, or their spores, are commonly present in garden soil and in the dust and sweepings of town streets, have been detected in splinters from the woodwork of houses, in stable manure, in the fæces of the horse, ox, calf, and other herbivorous animals, and occasionally in the fæces of man.

In nearly all cases of tetanus the virus can be shown to have entered the body through a

wound of the surface, and the cases are therefore known as "traumatic tetanus." The wound is usually situated on one of the limbs. Lacerated, contused, and especially deep punctured wounds are most liable to be followed by tetanus, but still more so if the wound have been contaminated with soil or manure, or have become septic. Wounds caused by wooden splinters and nails are notably dangerous, and gunshot wounds are not infrequently followed by tetanus, as is shown by the frequency of what is termed in the United States "Fourth of July tetanus." The occurrence of tetanus after surgical operations is now relatively uncommon. Tetanus has lately been recorded as occurring after vaccination, but as the vaccine lymph in question was proved by animal experiment to be innocuous, secondary infection of the vaccine wound had evidently taken place at some period subsequent to the act of vaccination. Tetanus has been known to follow hypodermic injections, as has recently been recorded by Moty (1901) in the case of quinine injections. In such instances the disease is usually the result of secondary infection. Of late a few cases of tetanus have been observed subsequent to the subcutaneous injection of gelatine in the treatment of hæmorrhage or inoperable aneurysm, and tetanus bacilli have been detected in commercial gelatine by Levy and Bruns (*Mitteil. a. d. Grenzg. d. Med. u. Chir.* 1902), and also by Schmiedicke (1902). A number of cases of tetanus, twenty of them being fatal, have been recently recorded after the use of antidiphtheria serum prepared in Milan and St. Louis. The Milan serum was, on investigation, found to contain tetanus bacilli, whereas the St. Louis serum was sterile, but contained tetanus toxin in considerable amount. Such accidents as these must be of exceptional rarity, and cannot occur in the case of sera which have been properly tested on animals. Tetanus is a not infrequent complication in soldiers wounded in war. In the recent Madagascar campaign there was considerable mortality from tetanus, and in the French colonial wars during the latter half of the last century the mortality due to tetanus among the wounded averaged 3 to 5 per cent (Calmette, 1900). In the Spanish-American war the Spanish losses from tetanus were severe, whereas in the last Boer war the disease was almost non-existent.

Puerperal tetanus and *tetanus neonatorum* may be regarded as special forms of traumatic tetanus, infection occurring from the female genital tract and from the umbilical wound respectively. In the tropics tetanus is often observed in epidemic form in new-born children, illustrating the fact that when there is a wound contaminated by soil or other infective material, and when asepsis or antisepsis is not carried out, tetanus is likely to supervene.

In exceptional cases no wound can be found, nor is there any history of a wound. These are the cases designated "idiopathic tetanus." In some of these instances there has probably been a wound so trivial as to have escaped detection; in others we may conclude from the researches of Thalmann (1900) and others that a lesion of the nose, mouth, respiratory or alimentary tract, served as the point of entrance of the virus.

The disease is more frequent in negroes than in white persons, but affects the latter more than the yellow races, and is more prevalent in tropical than in temperate or cold climates. It is common on the west coast of Africa, in the West India Islands, and in Cochin-China. In New York there were in 1899 seventy-three deaths from tetanus; in Baltimore in 1901, thirty-two deaths; in the hospitals in Vienna during 1899 there were 14 cases, of which 8 terminated fatally. In Great Britain the disease is relatively infrequent.

The tetanus bacillus is a small thin bacillus, about 2-5 μ in length; in cultures it often forms longer filaments. The bacillus possesses ten or more flagellæ, is slightly motile, and in cultures forms a terminal round spore, the diameter of which is greater than that of the vegetative cell, the bacillus thus assuming the drumstick or pin form.

The bacillus can be stained by any of the ordinary stains, and retains the stain when treated by Gram's method. The spore may be differentiated from the rest of the bacillus by the usual methods for demonstrating spores.

The bacillus is more readily cultivated at a temperature of 37° C. than at the room temperature; growth ceases if the temperature be below 14° C. The bacillus is usually regarded as an obligatory anaerobe. Growth is certainly most readily obtained in the entire absence of oxygen, and the addition of glucose or sodium formate to the medium favours growth. On the surface of gelatine the colonies are small, irregular, of greyish white colour; the margin of a colony, when seen under the microscope, presenting numerous thin, radiate projections. The medium is slowly liquefied. On the surface of agar each colony is whitish in colour, and is surrounded by a thin halo of fine, wavy, thread-like projections from its margin. Stab cultures in glucose agar or gelatine present in the deeper part of the medium abundant fine lines of growth, projecting at right angles from the needle track, the growth thereby assuming a resemblance to a bottle-brush or fir-tree. Gas is formed, and if the medium be gelatine it becomes liquefied. Glucose bouillon is rendered turbid, and gas is evolved, whereas milk remains unaltered. Of late years a number of observers (Carbonne and Perrero, 1895; Kruse, 1896; Grixoni, 1899; Debrand, 1902; etc.) have shown that the bacillus is by no means so

strictly anaerobic as was formerly supposed, and some have maintained that it can grow under aerobic conditions. This assertion is in part true, for the tetanus bacillus undoubtedly multiplies when cultivated in bouillon together with some other bacterium, for example bacillus subtilis, which absorbs oxygen from the medium; and further, both Zumpe (1899) and Debrand (*Annales de l'Inst. Pasteur*, 1902, xvi.) have shown that the tetanus toxin elaborated under such conditions is as virulent as the toxin obtained by the ordinary anaerobic methods. In other instances the bacilli cultivated under aerobic conditions have been avirulent, and have consequently been regarded as pseudo-tetanus bacilli. The tetanus bacillus does not grow in media containing no trace of proteid.

The vitality of the spores is well maintained for a long period. A wooden splinter, for instance, was proved to be virulent eleven years after removal from a case of tetanus (Henrijean, 1891). The spores are also markedly resistant. They are killed by five per cent carbolic acid in fifteen hours, by one per thousand mercuric chloride in three hours, by moist heat at 100° C. in from five to thirty minutes, according to their resistant power, but withstand moist heat at 80° C. for one hour. Exposure to dry heat at a temperature of 155° C. destroys them in twenty minutes.

There is much difference in the *susceptibility* of the various animal species to tetanus. The most highly susceptible are the horse and man, somewhat less susceptible are the goat, guinea-pig, mouse, donkey, and ox; still less susceptible are the rabbit, rat, dog, and cat. Pigeons, crows, and parrots are but little susceptible. The fowl is still more highly immune. Knorr (1897) states that the minimum toxic dose for the fowl is equal to the 0·001 part of the minimum lethal dose for the horse. Frogs, after inoculation, do not acquire the disease unless kept at 37° C. Lizards and tortoises have not yet been shown to be susceptible.

The usual modes of entrance of the virus into the body have been already mentioned. The introduction of spores into the healthy respiratory passages (Thalmann, 1900), or into the normal alimentary tract (Sanchez Toledo, 1890), does not cause infection, but the virus may gain entrance through a wound of the nasal mucous membrane, or through the alimentary tract (Suess, 1901), or the deeper parts of the respiratory tract when the latter are in a state of catarrhal inflammation. If the virus has been introduced into the subcutaneous tissues, it there finds anaerobic conditions well adapted for its existence and multiplication. The spores germinate, the resulting bacilli multiply, but remain localised at this situation, and do not invade the body, although in exceptional instances they may penetrate as far as the neighbouring lymph glands (Schnitzler and Büdinger, 1893). The bacilli multiplying, now elaborate their toxin, which is carried away to the spinal cord and medulla by the blood stream, and also, so it is supposed by some, along the peripheral nerves. A point of no little importance is that the introduction into the normal tissues of tetanus spores alone—all traces of toxin having been previously removed from the spores by washing with water, or by heat for twenty minutes at 65° C.—does not induce tetanus (Vaillard and Vincent, 1891; Vaillard and Rouget, 1892, 1893). If, however, the spores be introduced into damaged tissue, or be introduced together with some substance such as cultures of other bacteria, lactic acid, or other chemical substance, capable of inducing damage, or of exerting a negative chemiotactic influence on the leucocytes, the spores germinate and the bacilli form their toxin. The same result is attained by enclosing the spores in collodion sacs, and thereby protecting them from the leucocytes. In every case of natural infection with tetanus, spores alone are never introduced. The presence of some or other foreign substance in the wound usually implies the simultaneous presence of other bacteria, hence in most cases of tetanus there is mixed infection from the outset, and suppuration at the seat of the wound.

Tetanus Toxin.—All the features of this disease can be reproduced by injection of tetanus toxin obtained by filtration from cultures. The exact chemical nature of the purified toxin is still uncertain—Brieger and Boer (1896) found that it yielded no proteid reactions; Hayashi (1901) regards it as an albumose. In many respects it resembles the enzymes. Thus it is destroyed in a few minutes by moist heat at 65°C.; three hours' exposure to dry heat at 140° C. is required to completely destroy dry tetanus toxin (Morax and Maria, 1902); and in contradistinction to inorganic poisons such as strychnine, there is an incubation period between the injection of toxin and the first symptoms of tetanus. The purified toxin is extremely virulent; 0·000,000,05 gram suffices to kill a mouse weighing about 15 grams. The activity of the soluble toxin in filtered cultures undergoes reduction with age, on exposure to air or sunlight, or by the addition of chemicals such as iodine salts. This change is due to dissociation of the constituent elements of the toxin one from another, *i.e.* to the formation of toxoids which are relatively inert.

The toxin is absorbed from the wound into the blood. In the case of the guinea-pig the toxin remains in the blood for a relatively long period; whereas in the case of the rabbit and of man the greater part of the toxin soon passes out of the blood and becomes fixed in certain cells—mainly those of the central nervous system—which have an affinity for it. Nearly all investigators agree that the toxin is, after

death, contained in the central nervous system (Asakawa, 1898 ; Pasquini, 1902 ; etc.), but the presence of the toxin in other organs, in the cerebro-spinal fluid and urine, is very inconstant.

The incubation period varies according to the amount of toxin administered and the site of injection, but is always present even after very large doses. On subcutaneous injection of moderate doses the incubation period in man is four to seven days ; in the horse, five days ; in the guinea-pig, two days ; in the rabbit, two to four days ; in the mouse, two to three days. Courmont and Doyen explained this incubation period by supposing that the substance formed in vitro which one injects is not really the toxin, but merely an enzyme, the action of which on the organism results in the formation of the true toxin. They found that the blood of a tetanic dog produced immediate tetanic symptoms when injected into healthy dogs, and concluded that in such a case the true toxin, the effect of which was manifested without any incubation period, had been injected. We now know, however, from the investigations of Buschke and Oergel (1893), of Blumenthal (1897), Waring, Andrewes (1902), and others, that extracts from the spleen, liver, and other organs of animals or persons who have died of tetanus may cause tetanic symptoms within five to thirty minutes of injection, the probable explanation being that the toxin has combined with the cellular elements of the organs, and thereby acquired the capacity of inducing tetanic phenomena without any, or with only a very brief, incubation period.

Action of the Toxin.—It has been proved to produce the tetanic spasms by acting on the motor cells of the spinal cord and medulla oblongata so as to increase their irritability. The toxin has no action upon the muscular fibres or peripheral nerves ; curara inhibits the spasms, and section of a motor nerve causes the spasms to cease in the region it supplies. After injection of the toxin into animals, *e.g.* mice, the spasms occur first near the seat of injection. This fact has been interpreted in a variety of ways : according to Maria (1897) and many subsequent writers it indicates that part of the toxin is carried away by the peripheral nerves.

The toxin does not induce any characteristic change in the central nervous system. The various appearances, hæmorrhages in the anterior horns, degenerative changes in the motor cells of the spinal cord, etc., are not constant, and have been observed after injection of other poisons (Goldscheider and Flatau, 1897 ; Kossel and Westphal, 1898). The most satisfactory and most commonly accepted explanation of the action of tetanus toxin on the nerve cells is afforded by Ehrlich's side-chain theory (1897, etc.). According to this theory, the toxin possesses two groups of molecules : (1) a haptophoric group which has an affinity for similar groups of molecules—side chains—in the nerve cell, the toxin becoming thereby anchored or fixed in the cell ; and (2) a toxophoric group which, subsequent to the fixation of the toxin in the cell, increases the irritability of the cell-protoplasm. The fixation of the toxin in the nerve cells is a gradual process, requiring some time for its completion, and consequently there is an incubation period before tetanic symptoms arise. The nerve cells liberate or cast off those side chains which have combined with the toxin, and there is then a regeneration of side chains. If this regeneration be excessive the newly formed side chains pass from the nerve cells into the blood, still retain their power of combining with toxin, and now represent the antitoxin. The presence of preformed tetanus antitoxin in the spinal cord and brain of animals and of man has been proved by Wassermann and Takaki, Metchnikoff, Maria (1898), Danysz (1899), and others, and Babes (1899) has shown that brain substance also contains preformed rabic antitoxin. Yet although tetanus toxin is rendered innocuous by admixture in vitro with brain substance, the presence of preformed antitoxin in the nerve cells of an animal does not render it immune to tetanus toxin. Natural immunity to the toxin is due to the absence of cells possessing a haptophoric group of molecules with an affinity for tetanus toxin ; whereas acquired immunity to the toxin is obtained only by the presence of the antitoxin in the blood (*vide* "Immunity," vol. iv.).

When given by the mouth the toxin is innocuous (Ransom, 1898 ; Carrière, 1899 ; Cano-Brusco, 1901, etc.) ; its direct introduction into the cerebrum is followed by "cerebral tetanus" characterised by epileptiform attacks, polyuria, and psychical symptoms (Roux and Borrel, 1898). Binot (1899) states that the introduction of the toxin into the uterus, testicle, bladder, or kidney, induces not the ordinary tetanic spasms, but a peculiar condition which he terms "splanchnic tetanus" ; and Metchnikoff has found that the ovary of the hen contains substances which combine with the toxin in vitro. These facts show that there are cells, other than those of the spinal cord and medulla oblongata, with an affinity for, and capable of combining with tetanus toxin. In tetanus due to natural infection or to subcutaneous or intravenous injection of toxin, however, the toxin is mainly, if not entirely, fixed in the motor cells of the spinal cord and medulla oblongata.

Clinical Features of Tetanus.—The disease is more frequent in men than in women. The incubation period varies from about four days to four weeks, but is rarely longer. According to Rose, the earliest tetanic symptoms appear during the first week in 33 per cent of cases, during the second week in 45 per cent. The tetanic spasms commence in the muscles of mastication, the earliest symptoms being stiffness of the jaws (trismus) and of the neck. The

tonic spasms then involve the facial muscles; the eyebrows are elevated, the angles of the mouth are drawn outwards, giving the characteristic tetanic facies or risus sardonicus. The spasm of the muscles of mastication becoming more intense, the mouth can be opened very slightly if at all. The tonic spasms now involve the muscles of the trunk and limbs, and the patient's body becomes rigid throughout. Exacerbations of the spasms, associated with great pain, are brought on by slight stimuli such as a sound, touch, draught of air, or attempt to swallow. In a paroxysm the jaws are firmly clenched, and the patient's body, perfectly rigid (orthotonos), becomes arched backwards (opisthotonos), forwards (emprosthotonos), or to one side (pleurosthotonos). During the paroxysms the pain is intense, perspiration is profuse, the respirations are rapid or irregular; consciousness is maintained throughout. The temperature is either normal or elevated to a varying degree, but before death often rises to 105° F., and after death to 109° or 110° F. In fatal cases death is due to asphyxia from spasm of the respiratory muscles, to cardiac failure or exhaustion; or in rarer instances to cerebral hæmorrhage or aspiration pneumonia.

Cephalic (*facial*) *tetanus* is a special form of traumatic tetanus, there being a wound in the area of distribution of the facial nerve with paralysis of this nerve on the injured side, in addition to the ordinary signs of tetanus.

In *puerperal tetanus* infection is usually consequent upon abortion or abnormal labour, and is often due to the ignorance of midwives regarding asepsis.

Tetanus Neonatorum.—Difficulty in sucking is the earliest sign of importance, and is followed by tetanic spasms as in the adult. The prognosis is bad, death not infrequently occurring within one to four days.

Diagnosis.—The patient should be examined in order to determine the presence or absence of a recent wound, and if possible a bacteriological examination of the pus or tissue of the wound should be made. In nearly all cases there is mixed infection, but in not a few cases it will be found that tetanus bacilli cannot be cultivated owing to the fact that they have been already destroyed by the leucocytes and tissue cells. The presence of the toxin may, however, be proved by injection into animals of the discharge from the wound or possibly of the patient's urine. In the early stages of the disease, tetanus might be mistaken for rheumatism of the temporo-maxillary joint, or an inflammatory affection of the parotid or tonsils. In tetanus there is no local swelling or tenderness, but there is a tonic spasm of both masseter muscles, a fact which is elicited most definitely by the introduction of a finger into the patient's mouth. A more advanced case may be mistaken for one of strychnine poisoning. There is, however, no rigidity in the intervals between the paroxysmal spasms caused by strychnine, involvement of the muscles of mastication is a late phenomenon, and in an acute case death often occurs within twenty minutes after the onset of symptoms. Other conditions with which tetanus might be confounded are tetany, cerebro-spinal meningitis, hydrophobia, and hysteria.

Prognosis.—The shorter the incubation period the more severe will the disease be. The rapid involvement of different groups of muscles, severe and frequently occurring paroxysms, elevation of the temperature, and persistence of symptoms in spite of treatment, are unfavourable signs.

Prophylaxis.—When there is a wound contaminated by soil, manure, or other material likely to contain tetanus spores, it should be thoroughly cleansed, splinters, nails, or other foreign bodies being removed. It may be advisable to open up and drain a pre-existing wound, and if there be reason to suspect tetanus infection, a prophylactic injection of tetanus antitoxin should be given (5-10 c.c., which may be repeated). The prophylactic value of antitoxic serum has been amply demonstrated in the horse (Nocard, 1897).

Treatment.—The first and most important point is the neutralisation of any toxin still circulating in the blood and not yet fixed in the nerve cells. This can be effected with certainty by injection of tetanus antitoxin, which was first obtained by Behring and Kitasato in 1890. The methods of obtaining the antitoxic serum from actively immunised animals and of standardising the serum have been already considered (*vide* "Immunity," vol. iv.). Injection of tetanus antitoxin into animals protects them not only against the subsequent injection of tetanus toxin, but when injected after tetanic symptoms have appeared may even then effect a cure. When in men the first signs of tetanus appear, much of the toxin is already fixed in the nerve cells; but there is still toxin circulating through the body, and in many instances fresh toxin is still being elaborated by the bacilli in the wound. It is usually admitted that injection of tetanus antitoxin does not withdraw from the nerve cells the toxin already fixed in them; but it has been proved that antitoxin when injected does combine with, and thus render innocuous, the toxin which is still in the circulating fluids, or which the bacilli may yet elaborate. As the antitoxin does not influence the nerve cells already damaged by the toxin, it has consequently no directly curative action; but injection of antitoxin will effectually prevent any further fixation of toxin in the nerve cells, may therefore prevent a mild case from becoming severe, and as Ullrich (1902) remarks, obviates the necessity for amputation of the wounded part. Prior to the introduction

of antitoxin the mortality from tetanus amounted to about 80-90 per cent, although only about 45-50 per cent in the milder cases having a prolonged incubation period. With antitoxin treatment the mortality is reckoned at 34·4 per cent by Köhler (1898), 39·5 per cent by Lund (1898), and 43 per cent by Holsti (1899).

The antitoxin must be given as early as possible, in sufficient amount, and part thereof should be injected in the neighbourhood of the seat of infection. According to Behring, one must inject the serum not later than thirty hours after the appearance of the first tetanic symptoms, give not less than 100 units at one time, and repeat the dose frequently. Statistics show, however, that the sooner antitoxin is injected the greater is the mortality. Thus Haberling (Brun's *Beitr. z. klin. Chir.* Bd. xxiv.) in 14 cases in which antitoxin was given within thirty-six hours after onset of symptoms, found the mortality to be 71 per cent; and Ullrich, having collected 41 cases in which the serum was injected within thirty hours, found the mortality to be 72·9 per cent; whereas in 72 cases in which antitoxic treatment was commenced between the second and fifth days of the illness, the mortality was 45·5 per cent. The explanation of these facts is that those cases in which treatment was commenced early were the more severe cases.

The unsatisfactory results obtained by the subcutaneous injection of antitoxin have led to intravenous, intracerebral (Roux and Borrel, 1898), and subdural or subarachnoid (Blumenthal and Jacob, 1898) methods of injection being tried. In subarachnoid injection the needle of the syringe is introduced between the third and fourth lumbar vertebræ, 10-20 c.c. of cerebro-spinal fluid are withdrawn, and then the same quantity of antitoxic serum is slowly injected. In intracerebral injection, 2-3 c.c. of serum are slowly injected into the substance of the brain in front of the motor convolutions on both sides. Intracerebral injection appears, from the results of experimental research, to be the most efficacious method, but in practice it is of very doubtful value. Lambert (1900) has collected 52 cases treated by this method, the mortality being 63·46 per cent; 24 of the cases were acute, and in them the mortality was 87·5 per cent. On theoretical grounds the subarachnoid method is to be preferred. Descos and Barthélemy (*Compt. rend. de la soc. de Biol.* 1902) in 2 cases of well-marked experimental tetanus have obtained a cure by this method, whilst von Leyden and Blumenthal (1900) and others advocate the employment of this method, either by itself or in association with subcutaneous injections.

There are a number of dried and fluid antitoxic sera obtainable: Behring's, Burroughs and Wellcome's, Parke Davis', and Tizzoni's sera, and the serum of the Pasteur Institute, etc. Whichever preparation be used, the dose for subcutaneous injection is 10-50 c.c. of fluid serum, or five grams of dried serum dissolved in sterile water. The frequency with which the injections are repeated and the total quantity of serum given will depend on the severity of the case. The syringe must be cool, aseptic, and free of all trace of antiseptic.

The injection of brain substance as a therapeutic measure is based on the experiments of Wassermann and Takaki (1898), who found that tetanus toxin combines in vitro with brain substance and is thereby rendered innocuous, and that mice could be saved even when brain or spinal cord substance was injected several hours after the toxin. These facts have since been amply confirmed by Danysz (1899), E. Marx (1902), and others. Cases successfully treated by subcutaneous injection of brain substance have been recorded by Kadyi (1899), Krokiewicz (1899, 1900), etc. But in the hands of many others the treatment has not been satisfactory. And as tetanus toxin combines more readily with antitoxin in solution than with the preformed antitoxin of the central nervous system, the hypodermic injection of brain or cord substance is not to be recommended.

Baccelli's method of treatment by subcutaneous injection of 2-3 per cent solution of carbolic acid is reported to have been successful by many Italian writers. Ascoli (1899), for example, records thirty-three cases treated by this method with only one death. But experimental investigations prove Baccelli's method to be valueless. Courmont and Doyen (1899) have found that it hastens the progress of the disease in guinea-pigs. Von Török (1900) has observed that it does not save rabbits after injection of tetanus toxin, and Guillaumin (*Jour. de Physiol. et de Pathol. Gén.* 1902) has found that Baccelli's treatment, even when commenced at the beginning of the incubation period, does not check the course of tetanus experimentally induced in the horse.

The wound should receive local treatment in order that the tetanus bacilli and other bacteria present may be destroyed. The wound should be enlarged, all foreign matter removed, and an antiseptic dressing applied, with drainage if necessary. The patient's strength must be maintained by careful feeding. Liquid food is the most suitable, and if it cannot be administered by the mouth, it must be given through a nasal tube or per rectum. And, lastly, treatment must be directed to the symptoms induced by the toxin. The reflex irritability of the central nervous system must be diminished by strict isolation of the patient. He must be in a darkened room and protected from all noise. Narcotics must be given. Morphia in large doses is the most beneficial; chloral hydrate, bromides, curara, cannabis indica, or other nar-

cotics, are also useful in controlling the spasms, but chloroform is required if the paroxysms are very severe.

Tetany.

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See also ANTISPASMODICS; CONVULSIONS, INFANTILE (*Etiology*); PREGNANCY, AFFECTIONS AND COMPLICATIONS OF (*Nervous*); RICKETS (*Clinical Features*); STOMACH AND DUODENUM, DISEASES OF (*Special Symptomatology, Gastric Tetany*); TETANUS (*Diagnosis*); THYROID GLAND, MEDICAL (*Physiology*).

DEFINITION.—An affection characterised by tonic spasm, intermittent, remittent, or continuous, of the extremities; associated, as a rule, with sensory symptoms, and with an increase in the irritability of the muscles and nerves to electrical and to mechanical stimulation.

SYNONYMS. — Intermittent tetanus (Dance); idiopathic contracture (Teissier and Hermel); tetanilla (Trousseau); rheumatic contracture of nurses (Trousseau); tetany (L. Corvisart); intermittent rheumatic contracture; tonic occupation spasm; arthro-gryposis, etc.

HISTORY.—The discovery of this affection is usually attributed to Steinberg, who, in 1830, described it as a "rheumatic contraction of the extremities"; and to Dance, who, in 1831, published a memoir upon "A Form of Intermittent Tetanus." Before that date, however, as Risien Russell has pointed out, cases in which rigidity of the extremities was associated with spasm of the glottis were described by Clarke in his *Commentaries on some of the most important Diseases of Children*, published in 1815, these being obviously cases presenting the common association of carpo-pedal spasm and laryngismus.

In 1846 Delpech, Trousseau's assistant, wrote a thesis on *Idiopathic Muscular Spasms*, in which he described a number of cases. In 1852 the name "tetany," by which the affection is now generally known, was proposed by Lucien Corvisart.

The disease became generally known in this country through the writings of Trousseau, who collected a considerable number of cases at the Necker Hospital. As the earlier cases were in nursing women, Trousseau at first regarded the disease as special to nurses, and called it *Rheumatic Contraction occurring in Nurses* (*Contracture rhumatis male des nourrices*), but, as he himself says, he was not long in discovering that nursing is not the only favourable condition for its development.

The association of tetany with dilatation of the stomach was first described by Neumann in 1861, and since that time similar cases have attracted a great deal of interest.

A very severe form of tetany sometimes occurs in cases of complete extirpation of the thyroid. An account of such cases, occurring in Billroth's clinique, was published by Weiss in 1880, and the conclusions drawn from clinical observation have found support in the experimental investigations of Horsley, Schiff, and others upon the thyroid gland.

The toxic theory of the origin of tetany has led to experimental studies by Müller, Bouveret and Devie, Halliburton and M'Kendrick, and others.

CAUSATION.—1. *Age and Sex.*—Tetany is met with at all periods of life. If we regard the carpo-pedal spasms of rachitic children as a minor form of tetany, the affection is most common in childhood. Gowers collected 150 cases, of which 142 were available for tabulation according to age and sex. In the successive decades the cases numbered 42, 36, 24, 23, 13, 4. Above the age of twenty, women are more frequently affected than men. Trousseau speaks of the disease as most common in women between the ages of seventeen and thirty. In childhood, on the other hand, the spasms occur much more frequently in boys than in girls. Of the 42 cases in the first decennium 31 were boys and 11 were girls.

2. *Heredity.*—Sometimes several cases occur in a family. Thus Abercrombie quotes four cases as occurring in each of two families, and three cases in one family, at different times. Again, cases are recorded in which the patient had suffered from convulsions, or was morbidly irritable and impulsive, subject to outbursts of temper for trifling causes, or in some other way gave evidence of nervous instability. On the whole, however, the evidence is against the general existence of any particular neuropathic heredity in the subjects of tetany.

3. *Geographical Distribution.*—While tetany has a very wide geographical distribution it is in most places an infrequent disease. In some parts of the continent of Europe, however, it is comparatively frequent, especially in Vienna, where it is said to be becoming more common. In America true tetany is a very rare disease, and in this country it is far from common. The mild form which occurs in children is met with much more frequently than cases in adults.

4. *Season.*—Tetany is more common in winter and spring than in summer and autumn.

5. *Various Special Conditions.*—Tetany occurs under such a variety of conditions that it is necessary to attempt some classification of the

cases. The following grouping is that adopted by Frankl-Hochwart in his elaborate paper:—

Group I.—*Cases occurring in Healthy Individuals—Example: Epidemic Tetany.*—Tetany may occur in epidemic form, the cases being acute, running a course of two or three weeks, and rarely proving fatal. Such outbreaks have been observed especially in certain parts of the continent of Europe (*e.g.* Vienna). The victims are for the most part young men of the working-class, and particularly of certain trades. Frankl-Hochwart collected 360 cases from the registers of the General Hospital at Vienna between the years of 1880 and 1889. Of the total, 318 were men, and of these 141 were shoemakers and 72 were tailors. The majority of cases occurred in February, March, and April. Von Jaksch regards the disease as infectious.

In 1876 a peculiar epidemic of tonic intermitting spasm appeared at a girls' school at Gentilly in France. Probably some of these cases were genuine tetany, and the remainder were hysterical simulations.

Group II.—*Tetany associated with Gastro-intestinal Affections.*—Tetany may arise in definite association with various acute affections, such as acute dyspepsia, gastro-enteritis, peritonitis, and appendicitis. Diarrhœa plays a much more important part in causation when it is chronic and exhausting in character than when it is acute. Trousseau speaks of chronic diarrhœa as almost constantly present in his cases.

In exceptional instances obstinate constipation has been present, and the symptoms have been relieved by the administration of purgatives. Catarrhal jaundice and the presence of entozoa have also been regarded as causes.

Many cases of tetany have been observed in association with chronic affections of the stomach. Schlesinger speaks of a chronic benign form of tetany of gastric origin, and such a designation may be useful for the description of certain cases. A far more important group is formed by cases of a peculiarly severe type which occur in association with dilatation of the stomach. This association was described by Neumann in 1861, and by Kussmaul in 1869, and since then numerous cases have been reported. This form of the affection is usually very severe, and the mortality is very high. Frankl-Hochwart gives only one recovery in 11 cases of the more serious kind. In most instances of this class pyloric or duodenal disease has been present. In a few cases compression of the duodenum from without has been discovered post-mortem. Primary affections of parts of the stomach other than the duodenum, and primary atrophy of the stomach-walls, are much more rarely associated with this form of tetany.

Group III.—*Tetany in Acute Infectious Diseases.*—Trousseau met with many cases after cholera in 1854, and Aran after typhoid fever in 1855. Cases have also followed or complicated small-pox, measles, scarlet fever, diphtheria, influenza, pneumonia, malaria.

Group IV.—*Toxic Conditions.*—Tetany has been attributed to definite toxic conditions, especially to chronic ergotism. It has, however, been suggested that such cases may have been true tetany due, not to a specific poison, but to "general deterioration of the health from a defective supply of nutriment" (C. H. Fagge).

Alcohol, chloroform, morphia, and lead have also been regarded as possible causes in particular cases.

Albumin has been present in the urine in a number of cases, and glucose and acetone have also been found. Indicanuria is not infrequent, especially in children. Chronic disease of the kidneys has been discovered post-mortem in cases in which no abnormal constituents were noted in the urine during life. It has been suggested that such changes may indicate damage done to the kidneys during the excretion of some unknown toxic substance.

Group V.—*Tetany in Pregnant, Parturient, and Nursing Women.*—In a large proportion of cases of tetany some debilitating influence is present. Prolonged lactation is an important cause which has been mentioned already. In such cases the incidence of the disease may be determined by fatigue or exposure to cold. The disease may occur during pregnancy, in which case the symptoms are more apt to appear in the later than in the earlier months. The affection may reappear during successive pregnancies. Young girls are said sometimes to be attacked shortly before puberty.

Group VI.—*Extirpation of the Thyroid.*—Complete extirpation of the thyroid gland may be followed by tetany. Only one or two cases have been reported as occurring after partial excision. In one, at least, of these cases the part of the gland left behind was obviously diseased. Out of 78 cases of complete excision at Billroth's clinique 13 cases of tetany occurred. Tetany may be produced experimentally in dogs by excision of the thyroid.

Symptoms.—(*a*) *Prodromal Stage.*—Some writers describe a prodromal stage, characterised by headache, backache, weariness, occasionally giddiness, and frequently digestive disturbance. These symptoms may last for a few days before a sensation of tingling in the extremities ushers in the characteristic motor symptoms. More commonly the affection begins acutely with little or no premonitory sensory disturbance.

(*b*) *Motor Symptoms.*—The characteristic symptom is spasm of the hands and feet. The spasm is usually symmetrical. The hands are affected first, the feet later. In most cases the thumb is adducted or flexed on the palm, the fingers are pressed close together, slightly flexed at the metacarpo-phalangeal joints, and extended at the terminal joints. The palm is hollowed

by the approximation of the lateral borders. Trousseau compared the position to the accoucheur's hand when about to be passed into the vagina. In some cases the fingers are flexed so that the nails press upon and even injure the skin. Rarely they are fully extended, or the position is the "*main en griffe.*" The wrists are slightly flexed, and the fore-arms pronated. The upper-arms may be closely adducted to the sides, while the shoulders are free from spasm. In the lower extremities the toes are usually flexed and pressed together, and the feet are extended at the ankle-joint and inverted. The knees are usually extended, and the thighs may be strongly adducted.

In slight cases the extremities are affected alone, but in severe cases the spasm may be very widely spread. The muscles of the face may be affected, and the angles of the mouth drawn out into a grin. The ocular muscles may be involved, resulting in strabismus. Trismus may be present, but is rare. The muscles of the tongue may be affected, producing difficulty in swallowing and in articulation.

The head is more frequently drawn forwards than backwards. Opisthotonos, however, may be present, usually as a late symptom, and such cases may readily be mistaken for tetanus. The involvement of the thoracic muscles and of the diaphragm may cause serious dyspnœa. The abdominal muscles become tense and rigid, and in some cases spasmodic retention of urine has occurred.

The spasms are usually paroxysmal. In an attack of tetany there are usually several paroxysms separated from one another by an interval which varies from an hour or two to several days. The whole attack usually lasts for two or three weeks, but it may continue for several months. The paroxysm may cease suddenly. More commonly it passes off gradually, and in the reverse order to that in which it supervened. Between the paroxysms more or less contracture of the affected muscles may persist, especially in the arms, and if an attempt is made to overcome this either by an effort at voluntary movement or by passive manipulation, a fresh paroxysm is apt to be precipitated. The spasms have been described as continuous, remittent, and intermittent, but these varieties shade off into one another.

The spasm may persist during sleep, and even, according to Abercrombie, during narcotisation with chloroform. Cold applied to the affected parts will sometimes stop the spasm.

Between the attacks, as Trousseau accidentally discovered, the paroxysm may be reproduced "by simply compressing the affected parts, either in the direction of their principal nerve-trunks, or over their blood-vessels, so as to impede the venous or arterial circulation." *Trousseau's symptom*, as this phenomenon is called, is of considerable value in diagnosis, but it may be absent in otherwise typical cases. It has been attributed to ischæmia, but is now ascribed by most writers to direct irritation of the nerve-trunks.

Another sign of diagnostic importance is that known as *Chvostek's*. This phenomenon consists in the presence of such a high degree of irritability of the muscles and motor nerves to mechanical stimulation that a tap over either the muscle or the nerve will produce a muscular contraction. This hyperexcitability is not confined to the affected parts. It can often be readily demonstrated by a slight tap over the facial nerve, which will produce a momentary contraction of all the muscles supplied by the nerve, or by the particular branch which is struck.

The *electrical reactions* have been carefully studied by Erb, Frankl-Hochwart, and others, who have found an increased irritability to the galvanic current almost constantly, and to the faradic current rarely. The polar reactions are also altered, so that a more ready response is obtained with the anode than with the cathode. The contraction is more prolonged than in health, and a feature peculiar to tetany is an anodal opening tetanus.

(*c*) *Reflexes.* — The tendon reflexes vary. They have been found normal (Baginsky), exaggerated (Loos), or absent. The stiffness of the muscles may interfere greatly with examination.

(*d*) *Sensory Symptoms.*—Premonitory sensory symptoms may be absent, or there may be tingling and formication in the hands and feet before the attack begins. Numbness or anæsthesia may be present. The muscular spasms are attended by cramp-like pain in proportion to the severity of the paroxysm. Articular pains in the joints of the affected area are also described.

(*e*) *Vaso-motor and Trophic Phenomena.* — During a paroxysm the face may become congested, and the lips purple, and there may be cyanosis of the extremities, especially of the hands. Œdema of the dorsum of the hands and feet may be present, and the skin of the affected area may be red and tender to the touch.

(*f*) *General Symptoms.*—The temperature is usually normal. In some cases it may be slightly raised, and in one or two fatal cases there has been a high temperature at the time of death. The intelligence is unaffected, and in fatal cases the mind may remain clear till the end. To this rule, however, there are exceptions. Frankl-Hochwart states that he has met with hallucinatory confusion in three cases. Again the patient may die comatose, in which case the spasm does not necessarily pass off with the onset of the coma.

Tetany in Childhood.—Tetany is a much more common affection in children than in adults. It is most frequently met with in

a mild form often called carpo-pedal spasm. Several authorities, including Henoch, have sought to draw a distinction between cases of this kind in young children and the true tetany of older subjects; but there does not appear to be any sufficient reason for doing so.

A subject of great interest is the relationship between tetany and rickets. This association was supported by Cheadle, and recently Kassowitz has argued with great vigour that tetany, as well as laryngismus and other nervous affections of young children, are to be regarded as manifestations of rickets. This view has been opposed by Kalischer, Loos, Romme, and others, who assert, on the one hand, that many children who suffer from tetany are not rachitic, and on the other, that if tetany is a rachitic affection it ought to be much more common than it is.

Upon this question it may be said that cases of tetany unconnected with rickets certainly do occur in childhood. These cases closely agree clinically with those met with in adults. They occur in association with the acute infectious fevers, with acute diseases such as pneumonia, with acute dyspepsia, with entozoa, with acute, and much more frequently with chronic diarrhœa. The symptoms may be slight, but are often severe. The onset of tetany in the course of measles or of some other general disease appears to have a grave prognostic significance.

A much larger group includes the ordinary cases of carpo-pedal spasm. This variety of tetany is met with chiefly in children younger than those just referred to, the majority of cases occurring in children in their second year. These cases are usually very mild; the spasm is usually confined to the extremities; as a rule it is continuous, or if paroxysms occur they are very slight. Facial irritability is almost always well marked. Trousseau's sign is often absent or difficult to obtain. Diarrhœa is present in a large proportion of the cases. The occurrence of general convulsions is an important complication which may supervene at any time during an attack. The general opinion in this country would agree with Kassowitz in regarding these cases as rachitic.

As to the statements of some continental physicians that a considerable proportion of children suffering from tetany present no evidence of rickets, so far as such observations are not to be explained by the inclusion of a considerable proportion of cases belonging to the first series, we can only say that in the early stages of rickets the symptoms are often not very definite, and even good observers may disagree as to whether a child is to be called rachitic or not.

The comparative frequency of laryngismus in children suffering from tetany is a feature of much interest. Some observers state that it is present in one-third of the cases. This has led Escherich to go so far as to maintain that laryngismus is a pathognomonic sign of tetany even when the characteristic spasms are absent (latent tetany).

Martin and other recent French writers have described as tetany certain cases of isolated spasms in different parts of the body (*les formes frustes*). These are alluded to in the section on Diagnosis.

Morbid Anatomy.—As the mortality in tetany is very low the number of post-mortem examinations has been small. In those which have been made, changes in the nervous system have been slight or absent.

Necropsies on children have been made by Tonnellé, de la Berge, Abercrombie, Baginsky, Berger, and others. In some cases nothing abnormal was discovered. In others there was an excess of serum in the subarachnoid space or in the ventricles, hyperæmia of the pia, and areas of hyperæmia and œdema in the brain and spinal cord. Schultze found slight sclerosis in the cervical region of the cord on microscopic examination in the case of a child of eleven months, in which the nervous system appeared normal to the naked eye. In another child which he examined there were no microscopic changes.

Evidence of myelitis has been found in the cervical and lumbar enlargements of the cord in two children examined by Bonome and Cervesato. The principal alterations were found in the grey matter, and included degenerative changes in the nerve cells, especially those of the internal group of the anterior horn.

Some redness of the sheaths of the peripheral nerves has been noted in a few cases, but this may not have meant very much. Berger found nothing abnormal in the nerves on microscopic examination. Weigert, Loos, and Oddo have also failed to find changes in the nerves.

Observations made upon adults give practically the same results as those upon children. Trousseau describes, in the case of a young man, slight softening of the spinal cord, which he regarded, not as the cause, but as an effect of the disease. Langerhans found slight thickening of the small vessels—just such changes as might be expected in an elderly patient, and his patient was forty-eight. Very few cases have been examined in which the disease was of great duration. Imbert-Gourbeyre examined the body of a tailor, twenty-one years of age, who had been subject to tetany for six years. Injection of the surface of the brain with slight ecchymosis was present, and there were also slight changes in the spinal cord, especially in the cervical and lumbar enlargements. Death in this case was due to smallpox.

In cases of tetany due to extirpation of the thyroid the nervous system has been found normal, or any changes present have been slight and indefinite. Similar negative results have been obtained in the case of animals suffering

from tetany after experimental removal of the thyroid, by Schultze, Victor Horsley, Frankl-Hochwart, and others.

Pathogeny.—It is now generally agreed that tetany is an affection of the nervous system. It is more difficult to decide which part of the nervous system is specially affected. Some of the symptoms might be referred to the peripheral nerves (Hasse), but the usual distribution of the affection seems rather to point to derangement of the spinal cord, and this view is further supported by the muscular atrophy which occasionally results, and by the changes which have been found in the cells of the spinal cord (Erb, Berger, Gowers). Frankl-Hochwart refers some of the symptoms (*e.g.* the rarely observed polyuria and glycosuria) to the medulla, and he and others have also referred to the possible implication of the cerebrum in certain cases.

Among the theories advanced to account for the symptoms the most important are the dehydration theory put forward by Kussmaul and afterwards disclaimed by him; the reflex theory supported by G. Sée, Müller, and Berlizheimer; and the toxic theory which is accepted by most writers at the present day. The rôle of toxins in the production of nervous disorders has been discussed so fully of late that it is unnecessary to enter upon any general discussion of the subject. Among the points in favour of the toxic origin of tetany may be mentioned—the wide distribution of such lesions as have been found in the nervous system; the usual existence of some condition likely to lower the resistive power; the actual discovery of toxic substances in certain cases; and the occurrence of tetany in epidemic form.

It is interesting to compare the groups in which tetany occurs with Robertson's[1] classification of the sources of toxic infections which we have to consider in the study of nervous diseases. These are—

(1) Exogenous poisons. Tetany has been ascribed in rare cases to alcohol, chloroform, morphia, lead (Frankl-Hochwart's group 4).

(2) Poisons formed within the body in the course of various infectious and non-infectious diseases—typhoid, cholera, etc. (groups 1 and 3).

(3) Poisons generated within the body owing to disorders of metabolism. Here we would place the cases occurring in pregnant and nursing women (group 5) in whom metabolism is greatly increased, and also the cases following fatigue or exposure to cold which lower the resistive power of the nervous system. The cases of tetany following excision of the thyroid may also be included here (group 6). To certain organs, *e.g.* the liver, pancreas, lymphatic glands, is now attributed the function of neutralising toxic products of metabolic activity and of thus protecting the body from their influence. If the thyroid has any such rôle to play its removal will allow an accumulation of toxin to take place, and this, if not otherwise neutralised, may act on the nervous system, producing tetany.

(4) Poisons generated in the alimentary canal producing an auto-intoxication of gastro-intestinal origin (group 2). Bouveret and Devie found in the stomach, in cases of gastric tetany, a substance which produced convulsions when injected into animals. They associated the production of this substance with excess of hydrochloric acid in the gastric juice. Others (Ewald, Blazicek) have reported cases in which free hydrochloric acid was absent. Halliburton and M'Kendrick have recently described a toxic substance which they found in the stomach contents in a case of tetany and gastrectasis.

To sum up, tetany may be regarded as a group of symptoms produced by the action on the nervous system of a toxic substance or substances which arise under different conditions, and whose nature is unknown.

Diagnosis.—Nothing is easier than the recognition of tetany in a characteristic case. The diagnosis depends upon the onset, usually sudden, of the peculiar spasms in the limbs, their restriction to certain groups of muscles, the normal temperature, and the absence of cerebral symptoms. Moreover, Trousseau's symptom, Chvostek's symptom, and the altered reactions to galvanism (Erb's sign), are important aids to diagnosis.

In some cases diagnosis may be rendered difficult by the slightness of the symptoms, or their aberrant form. Some recent French writers describe as tetany cases of spasm involving only a single group of muscles, or even only a single muscle, such as one sterno-mastoid. Again, cases are met with in which the typical spasm is or has been present, but to only a very slight degree, while sensory symptoms, such as numbness and tingling, have monopolised the attention of the patient. In such cases the special diagnostic sign (Trousseau's, etc.) may be absent or doubtful. A careful study of the possible causes of the symptoms will often throw light on the diagnosis.

In other cases the intensity and generalisation of the spasm may give rise to difficulty in diagnosis. Trismus, stiffness of the neck, and opisthotonos are present occasionally in severe attacks, and are suggestive of *tetanus*. In tetany the spasms usually begin in the extremities and invade the trunk later, trismus is a late symptom, and is usually only slightly marked, the usual position of the hands and feet is characteristic, and the temperature is usually normal. The termination of the case also contrasts with that of tetanus, for most cases recover, although death from asphyxia or from some complication may occur.

Another disease for which the severe forms of tetany may be mistaken is *cerebro-spinal*

[1] *Text-Book of Pathology in Relation to Mental Diseases.* W. F. Robertson, 1900.

meningitis. In this affection there is usually fever, mental symptoms are a prominent feature, and the pain radiates along the nerves instead of being a cramp-like pain in the muscles. Examination of the cerebro-spinal fluid would aid in diagnosis by indicating the existence of inflammation.

Tubercular meningitis is to be distinguished by its insidious onset, the headache, the vomiting, the constipation, the irregularity of the pupils, the altered rhythm of the respiration, and the slowness and irregularity of the pulse. In children tetany is most common in the second year; tubercular meningitis between the ages of three and five years.

Hysteria may simulate tetany very closely. If a study of the antecedents of the patient and careful scrutiny of the symptoms do not clear up the diagnosis, the electrical irritability of the nerves should be examined. In hysteria this is unaltered.

Epilepsy, *Jacksonian epilepsy*, and *cerebral congestion* give rise to spasms, but can rarely be mistaken for tetany.

Tetanus neonatorum begins in the early days of life, and trismus is a prominent symptom and usually the first to be noticed. It results from infection through the umbilical wound. Perhaps no disease is so fatal. The occurrence of tetany in newly born children is denied by some writers, while others describe it as presenting all the symptoms of tetanus neonatorum, from which it differs in that trismus is slighter and appears later, and that recovery takes place usually in from ten to twenty days.

Prognosis.—Tetany *per se* is not a dangerous disease, and a fatal issue is rare in uncomplicated cases. When tetany occurs in the course of an exhausting illness death may result from the original disease, and may even be accelerated by the fatigue produced by the spasms. When the spasm is generalised, death may result from asphyxia.

In two forms of tetany only is the prognosis grave, namely, in that due to thyroidectomy and that due to dilatation of the stomach. In the former, however, the fatal issue may be averted by the administration of thyroid. In the latter, in which the mortality is estimated at from 70 to 75 per cent, treatment is unsatisfactory. Frankl-Hochwart has been quoted as giving a much higher mortality in these cases, but his figures suggest a tendency to regard the fatal issue as a test of whether a given case should be included in this group or not.

Treatment.—*Symptomatic.*—In order to reduce the number and severity of the attacks of painful spasm the patient should be kept at rest in a warm room. All unnecessary movement should be avoided. The diet should be nutritious and easily assimilated, the details being suited to the age and general condition of the patient. Warm baths are useful, especially in acute paroxysmal cases, and may be repeated several times in the day. The local application of cold may also give temporary relief to the spasm. Trousseau says the painful cramps in the legs are instantly relieved if the patient stands upon a cold stone or tiled floor.

Of drugs administered for the relief of spasm the bromides and chloral are generally useful. Calabar bean was recommended by Cheadle. For nocturnal tetany Gowers advocates a dose of digitalis at bedtime. When the paroxysms are very severe the inhalation of chloroform is indicated. The anæsthetic should be administered cautiously and with plenty of air, as there is some danger of spasm of the glottis occurring.

General.—The general line of treatment should be of a tonic character as is indicated by the usual underlying conditions. According to the special indications of the case, such drugs may be ordered as quinine, arsenic, iron, phosphorus, the hypophosphites.

Special attention should be paid to the condition of the gastro-intestinal canal. Astringents may be used for the purpose of checking diarrhœa, or, in view of the possibility of the symptoms being due to a toxin of intestinal origin, calomel in small repeated doses, B. naphthol, salol, or salicylate of bismuth might be tried.

The urine should be examined, as it may furnish indications for treatment. Means should be adopted to favour elimination by the kidneys, skin, etc. Russell states that the hypodermic administration of pilocarpine brings about rapid relaxation of the spasm as soon as diaphoresis is induced. Trousseau advocated bleeding from the arm in the case of patients of a vigorous constitution. Any benefit derived in this way may possibly have been due to elimination of a portion of the toxin.

Dilatation of the Stomach.—In cases associated with dilatation of the stomach lavage is now generally recommended, but it must be carried out cautiously, as the passage of the tube may excite a paroxysm. The diet must be attended to, and hyperacidity corrected if present. Mayo Robson recommends surgical treatment, and reports cases in which the "cramps" ceased after pyloroplasty.

Excision of Thyroid.—In tetany following excision of the thyroid the appropriate treatment is obvious. In a few cases of tetany due to other causes thyroid treatment has been beneficial, but it is not generally useful.

Tetany in Children.—The chief indication is to attend to the underlying cause. Diarrhœa is very commonly present, and may be treated with grey powder, calomel, bismuth, etc. If it has lasted for some time, as it usually has, small doses of laudanum with dilute nitric acid are often useful. In some cases irrigation of

the bowel may be indicated. If the spasms are severe chloral may be administered, preferably by the rectum. In the tetany of young children, as it is seen in this country, an antirachitic regimen is nearly always indicated, including cream, cod-liver oil, hypophosphites, with fresh air and sunshine. Exposure to cold must be avoided. The cold spinal douche is of the greatest value, and should be given once or twice daily, while the child is sitting in a couple of inches of warm water so as to avoid chill. This treatment is all the more indicated if laryngismus is also present.

Tetra-.—In compound words *tetra-* (Gr. τετρὰς, four) means four; e.g. *tetrabrachius* (united twins with four arms), *tetracid* (a chemical compound having four atoms of hydrogen which are replaceable by acid radicles), *tetramazia* (having four mammary glands), *tetranopsia* (having the field of vision limited to one quadrant), etc.

Tetrodon. *See* Snake-Bites and Poisonous Fishes (*Poisonous Globe Fish*).

Tetronal.—A non-official hypnotic drug, being, chemically, diethylsulphonediethylmethane ($C_9H_{20}S_2O_4$); in its chemical composition, action, and uses it closely resembles sulphonal, and, like it, may produce hæmatoporphyrinuria; the dose is from 10 to 20 grains.

Tetronerythrin. *See* Pigments of the Body and Excreta (*Lipochromes*).

Tetter.—A form of skin disease; generally used to indicate cases of impetigo, but also of eczema, psoriasis, and herpes.

Texas Fever. *See* Malaria (*Historical*); Parasites (*Sporozoa, Bovine Malaria, Redwater Fever*).

Textile Trades. *See* Trades, Dangerous (*Cotton, Flax, Linen*).

Thalamencephalon.—The hinder part of the fore-brain (prosencephalon) developed from the anterior cerebral vesicle; it consists of the optic thalami, subthalamic tegmental regions, pituitary and pineal bodies, the structures in the interpeduncular space, the optic nerves and retinas, and the posterior part of the third ventricle; it is also called the diencephalon or 'tween-brain. *See* Embryology (*End of Third Week*, etc.).

Thalamo-.—In compound words *thalamo-* (Gr. θάλᾰμος, an inner room, bedchamber, or couch) means relating to the optic thalamus of the brain, e.g. *thalamocele* (cavity of the thalamencephalon).

Thalamus Opticus. *See* Physiology, Cerebrum (*Structure*).

Thalassophryna. *See* Snake-Bites and Poisonous Fishes (*Fishes*).

Thalassotherapy.—Treatment of disease by sea voyages, sea bathing, sea water, etc. (Gr. θάλασσα, the sea, θερᾰπεία, medical treatment).

Thalline Sulphate.—A non-official drug, prepared from chinoline; it has the formula $(C_{10}H_{12}NO)_2H_2SO_4$, and is tetrahydroparaquinanosol; its action is as an antipyretic and antiseptic, and the dose is 3 to 8 grains.

Thamisin.—A patent substance used as a precipitant and deodorant in the disposal of sewage as practised at Henley (Reeve's process).

Thanato-.—In compound words *thanato-* (Gr. θάνᾰτος, death) means relating to death, mortal; e.g. *thanatognomonic* (indicative of death), *thanatomania* (suicidal mania), *thanatophobia* (morbid fear of death), and *thanatotyphus* (malignant typhus).

Thane's Method.—A method of finding the fissure of Rolando in cerebral surgery; if a line be drawn from the glabella to the inion, the upper end of the fissure will be found half an inch behind the mid-point of this line.

Thapsia. *See* Dermatitis Traumatica et Venenata (*Causes, Vegetable*).

Thebaine. *See* Alkaloids (*Thebaina*); Opium.

Theca.—A sheath or case; e.g. *theca folliculi*, the connective tissue covering or tunic of the Graafian follicle.

Theine.—Caffeine ($C_8H_{10}N_4O_2$), so called because it is present in tea (3 to 5 per cent). *See* Caffeina.

Theism.—The disordered state of the digestive and nervous system due to excessive tea drinking.

Thelitis.—Inflammation of the nipple (Gr. θηλή, a nipple).

Thely-.—In compound words *thely-* (Gr. θῆλυς, female) means relating to or belonging to the female as distinguished from the male; e.g. *thelyblast* (the female element of the nucleus of a cell which is bisexual), *thelymania* (satyriasis), *thelytocous* (producing females), etc.

Thelygonia.—Nymphomania, or, more correctly, the procreation of female children, or, simply, female offspring.

Thenar.—Relating to the palm of the hand (Gr. θένᾰρ, the flat of the hand), *e.g.* the thenar and the hypothenar eminences.

Thénard's Method.—A method of making whitelead from litharge, which may

lead to lead-poisoning in the operatives. *See* Trades, Dangerous (*Lead-Poisoning*).

Theobromatis Oleum.—The oil of theobroma or cacao butter, much used in the making of suppositories; it is got from the seeds of *Theobroma cacao* (from which, also, chocolate and cocoa are prepared), and it contains stearin, olein, and the alkaloid *theobromine* ($C_7H_8N_4O_2$); it does not become rancid when exposed to air.

Theobromine.—An alkaloid, dimethylxanthine, with the formula $C_7H_8N_4O_2$. *See* Theobromatis Oleum; Diuretin; Pharmacology; etc.

Therapeutics: Health Resorts.

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See also Balneology; Climate; Hydropathy; Meteorology; Mineral Waters; and under various diseases, *e.g.* Tuberculosis, Diabetes, etc.

This article is confined strictly to the consideration of resorts which depend on climate only, and not on the effect of mineral water, whether internal or external. Owing to the limitation of space the subject can only be dealt with very briefly; and it is impossible to do more than mention some of the most important. Descriptions of individual resorts must be sought for in more extensive works. New resorts are being opened out every year as the range of travel increases; and it becomes constantly more difficult to keep up with every fresh locality. The plan adopted in this article has been simply to take the most important and best-known resorts in each country and indicate briefly for what diseases they are best suited. The general conditions of climatic treatment are briefly dealt with at the beginning of the article.

Classification of Climates

The simplest classification of climates is into (1) Marine climates, which admit of no subdivision, and (2) Inland climates, which are divided into high altitudes and low altitudes, the desert being a special sub-variety.

Marine climates may be partially differentiated into coast and island climates. Of course in the case of small islands the whole climate is practically marine, though a very small amount of elevation above the sea-level makes a very considerable difference in the effect of the climate on some people who are sensitive to the influence of the sea. Examples of marine climates are the Riviera, Madeira, and Bournemouth; they are characterised by greater equability of temperature, greater warmth in winter and coolness in summer, owing to the presence of the sea, which delays radiation, also greater humidity and usually a larger amount of sunshine. In a country like England, where fog and mist are very prevalent inland during the autumn months, the amount of sunshine enjoyed on a greater part of the coast is very considerably more than in inland places, as the sea fogs are comparatively infrequent.

As to their effects on the organism, they vary considerably; some, *e.g.* the resorts on the east coast of England and the eastern portion of the south coast, are very bracing, those in the far west and such places as Madeira are distinctly relaxing, whilst others are intermediate: much depends on the exposure, the prevailing winds, and the soil.

If we compare the effects of the marine resorts with those experienced inland, and especially at high altitudes, a great difference is observable, but hardly greater than may be observed between a very bracing and an enervating marine resort.

Perhaps the greatest difference is noticeable in the effect on the central nervous system, which in the case of high altitudes is much stimulated, whilst the sea almost invariably exercises a soothing influence. So great is the stimulation at elevations of 5000 feet and over that very unpleasant nervous tension is frequently produced by prolonged residence, and insomnia is a very common result. On the other hand, in a great majority of cases insomnia is benefited by a visit to the seaside.

In both cases metabolism is increased and appetite improved, but the so-called "biliousness," accompanied by constipation, of which many people complain on the coast, does not appear in mountain resorts. The way in which metabolism is influenced must therefore certainly differ in the two cases, but we have at present no physiological explanation to offer.

Increased activity of mind and body is a very marked feature of such climates as the Engadine and Colorado, and the sense of bodily fatigue is greatly diminished, which in itself is a danger to phthisical patients, as they thereby fail to notice the point at which they should check themselves.

Some things, such as the increased rapidity of pulse and respiration, are naturally accounted for on physiological grounds by the diminished supply of oxygen; but there are other factors, such as the electrical conditions, the effects of

which are little understood. No one who has resided at high altitudes can have failed to notice the peculiar condition of nervous irritability which affects both man and beast during the prevalence of certain atmospheric states, somewhat similar to that which affects some people during a thunderstorm, but much more marked.

We have yet much to learn as to the physiological effects of high altitudes and diminished atmospheric pressure, and observers are by no means agreed in the results which have been obtained. Paul Bert, Egger, and others maintained that one of the first results was a notable increase in the number of red blood corpuscles, which they attributed to the deficiency of oxygen causing a greater need of oxygen carriers; but considerable doubt has been cast on these results, though the latest observations tend to confirm their truth.

Besides the diminished pressure and increased rarefaction of the air, there are several other points of importance in the atmospheric conditions at high altitudes.

(1) There is much greater transparency and diathermancy owing to the low degree of absolute humidity.

(2) There is greater difference between the sun and shade temperature, and the daily range of temperature is greater.

(3) The absolute humidity of the air is much lower owing to the lower temperature.

(4) The air is purer, being freer as a rule from inorganic dust and from micro-organisms, though not more so than true ocean air.

It is the presence of these qualities which makes the high climates so valuable in the treatment of phthisis and gives them their peculiarly stimulating qualities; and in addition there is an amount of electricity in the atmosphere of regions such as Colorado, the effect of which it is difficult to estimate, but which certainly has a remarkable effect on the nervous system.

The desert climate has something of the same effect as that of high altitudes, and the air is remarkably pure owing to its coming from a large and practically untainted area. The effects on the nervous system are much less in degree, but some people find it very stimulating, and it is not rare to meet with those who suffer from insomnia in Egypt, when living in or close to the desert.

Climate and its Effects

Change of climate has become one of the most ordinary therapeutic measures in these days: to an infinitely greater degree since the expenses of travel have so much diminished, and the facilities so enormously increased. For one person who was sent abroad fifty years ago, probably fifty are sent now, and the increase has been very great in the last twenty years especially. The advantages of change of climate are fairly obvious, and have probably come within the personal experience of most men at some time or other.

We may look at the matter from either the physical or the mental point of view. (So far as the physical side goes, we are concerned here with climatic effects only, the question of baths being dealt with in another article (*v.* Balneology)). But, as a matter of fact, it is almost impossible to separate the results of the two factors. On the one hand, we may see a physical condition markedly improved when the sufferer is removed from domestic and business worries; on the other hand, mental depression may disappear like mist with the sense of physical well-being which a bracing climate produces. "Caelum non animum mutant qui trans mare currunt" is one of those proverbial generalisations which, after all, have only a limited application. Much, very much, depends on the constitution of the individual—much on the nature and causation of his ailment. It may be perfectly true that for the melancholic, the confirmed neurasthenic, the early general paralytic, for the man who has failed in life, has sustained crushing personal misfortune, or committed a hidden crime, mere change of climate may be useless or worse than useless, but, after all, such cases are the exception. There remain an immense number, the overworked, the over-anxious, the bored, the hypochondriacal, for whom a judicious shifting of scene may form a fresh starting-point, and it is precisely the organisations which are liable to these troubles, because they are somewhat unevenly balanced, which are also specially susceptible to the effects of climatic change. Personal susceptibility to changes of weather and climate varies indefinitely, and is generally inversely related to the mental and physical robustness of the individual. The tireless worker will, as a rule, be found to be one whom no vicissitudes of weather materially affect.

Meteorology as a science is not to be dealt with here, but we may ask, What do we mean by climate, and what are the conditions that determine it? before going on to the consideration of actual health resorts. As a matter of fact we very rarely talk of climate except in relation to life of some kind, and we really mean by it the sum-total of the physico-chemical conditions, permanent or changing, in any given locality which affect life, whether it be animal or vegetable.

The determining conditions of climate in a place may be summed up as follows:—

(1) Latitude.

(2) Altitude.

(3) Orientation.

(4) Relation to sea, whether the centre of a continent, island, etc.

(5) Relation to mountain ranges (which is a

question quite apart from that of altitude), forest, river, lakes, etc.

(6) Geological conditions of soil.

From these conditions result the various factors of climate, temperature, rainfall, winds, cloud, atmosphere, sunshine, humidity, electrical phenomena, the observation of which is the function of meteorology. But if we ask ourselves whether, in the present state of our knowledge, given all the data, we can predict the climate of a locality, and further, what its effect is on human beings, our answer must be a very guarded one.

There are subtle differences in the climate of places, often of places in close proximity to one another, which depend on factors of which we know nothing, yet the effects may be very obvious, not only on human beings but on plants and animals. The conditions are so complicated that it is impossible to disentangle the various influences at work, and we are really dependent in the last resort on empirical evidence. This being so, we may ask how far we can lay down any rules for the effects of climate on disease. Here again we cannot return a very definite answer; there are only a few facts which are well assured, and the rational basis of which is not far to seek. It is quite certain that high inland resorts, where the oxygen is deficient, the skin dry, evaporation rapid and perspiration suppressed, are bad for sufferers from renal disease; they are bad also for many cases of cardiac valvular disease, though by no means all. Further, it is obvious that chronic bronchitis and persons with a sensitive mucous membrane will do best in a warm equable climate, with little wind, and a moderate amount of moisture.

When we get beyond a few elementary generalisations of this kind we are completely at a loss, so far as scientific reasoning goes. It might be supposed that the drier the climate the better it would be suited for rheumatism in its various forms, but this is by no means the case: in many cases the symptoms are distinctly worse, probably owing to the rapidity of evaporation from heated surfaces in high dry climates.

Again, who is prepared to say what is the ideal climate for phthisis, when so much depends on the character or stage of the disease, and so much on the idiosyncrasies of the individual. It matters not what health resort you visit, whether by the sea or in the mountains, you will find a large number of phthisical patients who attribute their recovery to the place, and are confident that they would not have got the same benefit elsewhere. This goes a long way to prove what is now strenuously contended for, that any healthy locality where there is abundance of fresh air is suitable for the treatment of phthisis, whether it be high or low; but the writer has a strong opinion that to obtain the best results each individual must find the climate that suits him best. The vast majority of people feel better in one climate than another, and know very well where they are at their best. There is an "optimum" climate for the individual, just as there is an "optimum" temperature for different bacilli, and provided that that climate is not definitely contraindicated by the physical condition, each individual will do best in the climate he likes best. The present writer cannot agree with those who hold that difference of climate makes no difference, *e.g.* in the rate of healing of tubercular lesions, other conditions being equal; but this is a point which it is almost impossible either to prove or disprove. The upshot of this is that that medical man will act wisely and probably do the best for his patient, who within certain wide limits consults the patient's own likes and dislikes, and does not on *a priori* grounds commit him to Colorado or Madeira. In some cases, of course, it is impossible to be too emphatic as to the inadvisability of certain climates, but much *a priori* reasoning on the subject is falsified by experience. It might be supposed, for example, that altitude and diminished pressure would be bad for aneurisms, but this is absolutely not the case, unless there be valvular disease or extensive aortic degeneration associated with it.

There is a climate which has many of the advantages of the high altitudes, viz. the bracing effects and purity of air and dryness, without the disadvantages of diminished pressure and cold: that is the climate of the desert, best obtained in Egypt or inland Algeria. We shall return to this later in dealing with separate health resorts.

This part of the subject will best be closed by a word of warning as to journeys which are not infrequently fatal to invalids before they have arrived at their destination. Personal experience has convinced the writer that many invalids, and especially those who have not the means to travel in luxury, would have a far better chance of recovery if they remained at home, with home interests and home comforts. This applies particularly to those whose bodies are very dependent on their mental conditions, and who stand a good chance of finding themselves stranded in a strange country with no friends and no occupation, and with nothing to dwell on but their own physical condition. This point is often unconsidered when the question arises of sending people abroad, yet it is one of the greatest importance, especially in the case of phthisical patients, many of whom belong to that type of mankind in whom the mental factor is very predominant. In the choice of a health resort for an individual case we have, therefore, first to consider whether the bodily condition is such as imperatively to demand a certain climate or debar others, *e.g.*

whether the presence of renal disease makes warmth absolutely indispensable. It is assumed that the patient is in a fit condition to travel, though, as we have already said, it is far from being the case with all patients sent abroad. We then have to consider what range of places is open for choice, and to select that one which seems best suited to his physical and mental condition, and to his purse. The latter is an important point, as it is better for many if not most to live in comfort in a place which may not be the absolute best, rather than have bad rooms and bad food in some spot which might perhaps suit them rather better from a climatic point of view.

Finally, we shall do well to impress on patients that they should study the peculiarities of the climates to which they are going, and on their first advent seek the advice of some competent physician practising in the place.

Reasons for sending Patients Abroad

When we come to consider the reason for which patients are sent abroad, and the diseases which are the cause of their seeking advice, we find, as a matter of fact, that an overwhelming proportion of those who are definitely ill go on account of some tuberculous trouble. This is, of course, exclusive of the very large class who go for hydropathic treatment, whether external or internal, with whom we have nothing to do. Of those who go abroad during the winter, a large majority will be found to have had some signs of pulmonary or other tuberculous disease, probably far more than appears at first sight, the original cause being lost sight of in a good many instances or cloaked under some such term as bronchitis. Besides these, there are, of course, a great many cases of genuine bronchitis or emphysema, sufferers from which find themselves much freer from their trouble in a milder and drier winter climate. Further, there are a certain number of patients with chronic renal disease, diabetes, or cardiac trouble, to whom warmth is of the greatest importance, and who prolong their lives materially by avoiding the cold of an English winter.

There is also a large class of sufferers from rheumatism in its various forms, who find relief, if not cure, in more southerly latitudes, and are at all events able to be out and about a good deal more than they would be at home.

Lastly, there are the aged, the worn-out and over-worked, the weaklings, the people with poor physique, feeble circulation, and defective development generally, the hypochondriacs and neurasthenics, who, if they do not expect complete recovery, prefer to minimise the evil of existence by basking, so far as they can, in warmth and sunshine.

If we turn now to the climates which are regarded as useful for these various ailments, we notice first that, as has already been said, almost every kind of climate has been recommended for tuberculosis, from that of the high mountains to Madeira, but the high, dry, cold climates, such as the Engadine, Colorado, or South Africa, are pre-eminently suited for pulmonary phthisis, though unsuitable in many other morbid conditions. On the other hand, the warm climates, whilst they may be beneficial to phthisis according to their bracing qualities and the degree of humidity, are also valuable in numerous other cases. Such climates are those of Egypt and the African desert, the moderate elevation (2000-3000 feet) of the Australian plateau, parts of New Zealand, and in a less degree the Riviera. If analysed on a meteorological basis they are very different, and very different in their effects, but they constitute a large intermediate class of climate with very diverse applications, including the treatment of tuberculous conditions. There remains a class of warm, moist climates, such as Madeira, the West Indies, and other tropical or semi-tropical places, which are definitely unsuited for most cases of phthisis or tubercular disease, and are chiefly valuable for the aged, the feeble, and people with irritable mucous membranes, who are not susceptible to the depressing influences of moist, relaxing air.

Thus classified in relation to tuberculosis, which is after all the main test, we have three varieties of climate, viz. that of high altitudes, suited to the consumptive; a very large intermediate class, with variable characteristics, but bracing, moderately warm, and at least fairly dry; and the third class, which is for the most part unsuited to phthisical patients, though beneficial in other pulmonary conditions. It is to the large intermediate class that sufferers from the other ailments, which climate benefits, for the most part resort.

English Health Resorts

Taking the marine resorts first, we may begin with the south coast. We may begin at the east, and if we except Dover, which is not much frequented by invalids, we come first to Folkestone, one of the most popular places on the coast, with a distinctly bracing climate on the high ground and a rather milder one in the lower parts of the town.

Near by are Sandgate and Hythe, which are quieter and less bracing.

Hastings and St. Leonards have a comparatively mild climate, and are mostly frequented in winter, but are not so well suited for the really delicate as the south-western resorts and the Isle of Wight, and, like all the resorts of this section of the coast from Folkestone to Worthing, are cold in the spring months.

Bexhill, farther west, is a growing place, with a very bracing climate.

Eastbourne is chiefly a summer and autumn

resort. It is sheltered from the south-west by Beachy Head, but fully exposed to the east, and therefore cold in the spring.

Seaford is a quiet but growing place to the east of Beachy Head, and therefore sheltered from the east winds to some extent.

Brighton has a very bracing climate, and, though not facing so much east as Eastbourne, a large amount of east wind in the spring. The autumn and early winter months are often delightful, and, like most of the towns on this part of the coast, it enjoys a larger amount of winter sunshine than almost any part of England, except Torquay and Falmouth; about 450 hours yearly more than London. The chief season is autumn and early winter, but it is largely frequented at most seasons owing to the easy access from London.

Worthing, though near by, has a milder climate, and is noted for its fig gardens.

Passing by Bognor and Littlehampton, both quiet little places with good sands, we come to the Isle of Wight, where Ventnor, on the under cliff of the southern shore, shares with Bournemouth the reputation of being the best resort for consumptive patients in England. The climate is much milder than any of the mainland resorts, except the Cornish, yet not relaxing, and the place is well sheltered by the downs behind.

Bournemouth, though less sheltered, is favoured by a dry sandy soil and extensive pine woods; the climate is more bracing than that of Ventnor.

Weymouth has a fairly bracing climate and fine sands.

Sidmouth, near the mouth of the Exe, is remarkably sheltered, and has a large amount of winter sunshine.

Torquay has a reputation for pulmonary cases second only to Ventnor and Bournemouth, but is much more relaxing, warmer, and moister; less so, however, than Falmouth, which is well suited for bronchitic patients, and especially for those who have spent their lives in tropical or semi-tropical climates. It has a higher temperature and less daily range than any place in England, except the still more westerly Penzance and its neighbourhood, but is more sheltered than the latter.

On the north coast of Cornwall are St. Ives, Newquay, and Bude, all more bracing than the southern resorts.

Ilfracombe is the principal health resort of the North Devon coast. It is somewhat exposed, but has a mild winter climate.

Clevedon and Weston-super-Mare have long had a reputation in the west of England; the latter is the more bracing, and is specially beneficial to children.

In Wales, Tenby, Aberystwith, and Barmouth are the best-known resorts in the south, and in the north Llandudno, Colwyn Bay, and Rhyl, which are much frequented by the inhabitants of Manchester and Liverpool.

Inland resorts in England, apart from those places which have baths and mineral waters, are very few in number—in fact, Malvern is almost the only one of note. Great Malvern has an elevation of 520 feet, and an equable but fairly bracing climate. It is largely visited by invalids of all descriptions and those who need recuperation after hard work or illness.

Ilkley in Yorkshire is a similar recruiting place for the inhabitants of the large Yorkshire towns, but is practically only a summer resort.

Some of the spas, such as Harrogate and Buxton, may be visited for their climates as well as their waters, but have only a summer season.

More inland resorts are greatly to be desired in England, as at present the health resorts are almost confined to the coast; but in the English climate it is difficult to find inland places which would be suitable all the year round.

Two which should be mentioned, though the accommodation for visitors is scanty, are Hindhead in Surrey, at an elevation of 800 feet, and Crowborough in Sussex, which is a little more. The elevation for the south of England is very considerable, and both possess bracing climates. There is a good hotel in each place, but otherwise house-room is rather difficult to get, most of the houses being in private hands and likely to remain so.

Scotch Health Resorts

The well-known places on the west coast are more to be regarded as summer pleasure resorts than as health resorts, and are for the most part too humid for invalids; the best known of them are Wemyss Bay, Helensburgh, Rothesay, and Oban.

On the east coast, which is drier and more bracing, but very cold during the spring months, when winds from the east and north-east are prevalent, there are several resorts of considerable value, of which Nairn, Strathpeffer (apart from its baths), Portobello, and North Berwick are the best known.

During the summer, autumn, and early winter, the climate presents considerable advantages over most parts of the British Isles, the air being dry and invigorating and well suited for early phthisical cases and those which need bracing.

These are all seaside places, and many more could be named on the same coast. Of inland resorts Pitlochry in the Perthshire Highlands, but at no very great elevation, and Braemar are the two best known. The latter at an elevation of 1100 feet comes nearer to being a mountain resort than anything else in Great Britain, and has a most delightful and invigorating climate. It is crowded during July and August, but is said to be delightful during May and June and in the autumn, though of course rather cold. Those who cannot go to Switzerland will get

many of its benefits here and find excellent accommodation.

Ireland

Ireland, whilst affording many spots much frequented by sportsmen and tourists, cannot be said to possess any well-known health resorts. It is for the most part too damp and uncertain a climate for invalids, and in all except a very few places the accommodation is limited and apt to be rather rough.

Foreign and Colonial Health Resorts

Space will not admit of more than a very brief notice of the main health resorts outside the British Isles, and only those will be mentioned which are frequented by English visitors.

In Europe the principal are—(1) the highlands of Switzerland, *i.e.* the Engadine, Davos Platz, Arosa, and a few in Germany and Austria; (2) the Riviera, Italian lakes, and Mediterranean resorts, such as Algiers, Tangier, Malta, and finally, Egypt, which, geographically, is better classed with Europe than with Africa, the only other health resorts of that continent being in the extreme south.

Outside Europe and the Mediterranean there are not a great number of places visited by English people habitually, but there are many districts to which they frequently emigrate in the hopes of settling or finding employment in a good climate. The most important of these are South Africa, and especially the highlands of the interior of Cape Colony and the Orange River Colony; the great plateau of the North American continent, particularly Colorado, and the coastal state of California; certain districts of Australia, such as the Riverina and the Darling Downs; a good part of New Zealand (with the exception of the extreme north and south); and the islands off the north-west coast of Africa: Madeira and the Canaries.

The West Indies are hardly a health resort, though a good many people now go out there in the winter partly for the sake of the voyage.

Switzerland

It will be best to begin with those nearest home, and we may therefore take first the high-altitude resorts of Switzerland, of which Davos Platz is the oldest and perhaps, on the whole, the most frequented.

It is situated in the Canton Grisons, about 5000 feet above the sea, and well sheltered from the winds, so that the air is particularly still. It enjoys some 1800 hours of sunshine during the year, or rather more than any place in England, and the climate is especially delightful in winter, when clear, bright, still days are the rule. It can now be reached by rail from Zandquart and Coire.

Arosa in a neighbouring valley and St. Moritz in the Upper Engadine are resorts of a similar character, but about 1000 feet higher. The latter is not so well suited for the more delicate consumptives, as it is less sheltered and windier than Davos or Arosa.

Les Avants, above Montreux, on the Lake of Geneva, about 3500 feet, has less snow than Davos, and is suitable for cases which require less elevation.

Less known and more modern resorts are Leysin, near Aigle, in Canton de Vaud, and Montana, above Sierre, in the Rhone valley—the former at an elevation of 4700, and the latter of 5000 feet. All these resorts are open summer and winter, the worst time being the late spring, when the snow is melting, and great care has to be taken to avoid chill. Davos may be said to be exclusively for consumptives, but St. Moritz is frequented largely even in winter by those who merely want a bracing climate and the enjoyment of winter sports, such as tobogganing and skating.

The remaining very numerous resorts of Switzerland, including such well-known places as Zermatt, Belalp, Grindelwald, Mürren, Pontresina, and the Maloja, are all summer places, and are chiefly frequented by holiday-makers and climbers. Grindelwald is now open in winter, but is not suited for invalids.

Of the lower resorts, which are much frequented by visitors in autumn and spring, and invalids on their way to or from the higher places, the best known is Montreux, on the Lake of Geneva, at an elevation of 1200 feet; but there are many others too numerous to mention.

Italian Lakes

There are numerous places on the Italian lakes which are visited extensively by English people, but few of them are much frequented by invalids. Of these Locarno and Lugano, on the Lago Maggiore and Lago di Lugano respectively, are among the best known; they are both in Switzerland, though belonging to the Italian lake district, and both are used by invalids as temporary resting-places in the spring and autumn. In fact, most of the places in the lakes, such as Varese, Cadenabbia, on Lake Como, and Gardone Riviera, on Lago di Garda, are of the same character and only have a comparatively short season.

The same applies for the most part to the resorts of Southern Italy, such as Castellamare, close to Naples, Sorrento, on the Bay of Naples, Capri, and Amalfi. A few invalids go there to winter, but the majority are birds of passage.

In Sicily, with the exception of Palermo, which is a good deal frequented by pulmonary sufferers, the accommodation is not sufficiently good for invalids, and is rough even for ordinary visitors.

There are good hotels at Sorrento and Amalfi, and, of course, in Naples, but Naples is not to be recommended for invalids. A good many

sufferers from chronic or stationary pulmonary disease may pass the winter very well in these southern Italian resorts, but they must not overrate the warmth they are likely to experience there any more than on the Riviera. In exceptional winters snow may fall even at Palermo, though rarely.

The few resorts on the Italian Riviera will be dealt with in conjunction with the French Riviera.

The Riviera

For about fifty years the Riviera has been one of the favourite resorts of English people; and for a long time, when travel was much more restricted than it is now, and much more the monopoly of the wealthy and luxurious, the Riviera was the fashionable wintering-place of the English upper classes, its only rival being Madeira, which was exclusively frequented by consumptives, often of an advanced type. The latter also went to Mentone in large numbers. Since the high Alpine resorts have come into fashion Madeira has been discredited, and rightly, and Mentone rather strives to exclude consumptives, who are not received at many of the hotels.

From its proximity to this country the Riviera must always remain a favourite resort with English people, as there is no other place within easy reach where sunshine and comparative warmth in winter are so easily to be obtained, or where accommodation so good and often luxurious can be got by those willing and able to pay for it. The Riviera stretches from Toulon to Genoa, and what is often called the Italian Riviera, from Genoa almost to Spezzia; it consists of a belt of land which varies in width from one to four miles, extending from the sea to the foot-hills of the Maritime Alps. The mountains rising behind to a height of 3000 feet more or less form a protection from the north, and, according to the locality, also from the north-east, north-west. The neighbourhood of the Mediterranean, with its large mass of water at a comparatively high temperature, together with the backing of mountains, is the cause of the mild climate as compared with other places in the same latitude.

The season for the Riviera is from November to May, though not many visitors arrive before the middle of November, and few stay on after the end of April. The intervening months are very empty, and most of the hotels are closed. It is a great mistake for invalids to leave the Riviera too early, particularly if they return straight to England, while the weather is still cold and the journey may be a serious risk. Speaking generally, they should not leave at the earliest before the middle of April. With regard to accommodation, there is a wide choice and no lack of comfort, but it is most important that invalids should have their bed and sitting rooms facing south, as otherwise much of the benefit of the climate will be lost. French and Italian houses are also much more difficult to keep warm than English ones, the only means of heating being an inadequate wood fire.

Many people who winter on the Riviera for the first time make a great mistake in not providing themselves with suitable clothing. They expect only warm weather and do not bring the thick clothes required for an ordinary English winter, which are often equally necessary out there, although after the beginning of March thinner things are generally needed. It is always desirable for invalids to carry an extra wrap, as the changes of temperature in going out of the sun down a shady street are often great, and a severe chill may be incurred. Care should also be taken not to be out after sun-down, as, whatever the truth may be as to the fall of temperature at that time, an invalid may suffer severely from neglecting this precaution. There can be no doubt that the Riviera has in these respects a somewhat treacherous climate, besides the further drawback of very cold north-east and north-west winds in the spring. Speaking generally, however, its temperature is 10° F. higher than that of London during the winter months, the rainfall is much less, fog is almost unknown, and snow falls very rarely. The most rainy months are September and October and sometimes March. Looking to these facts, the Riviera climate may be described as dry, warm, and bright when compared with other districts in the same latitude, also stimulating; its drawbacks are the high winds just mentioned, the difference between its sun and shade temperatures, and the chill at sunset. Also to some people it is found, owing to this stimulating quality, to be very depressing, and those suffering from insomnia or nervous irritability may find their condition aggravated by residence on the coast.

Among the individual health resorts the most sheltered are San Remo and Mentone, which have less of this exciting quality, while Cannes on the whole has it the most. Nice is no longer so much of a health resort as a social centre, both on account of the amusements to be found in the town itself, and also because of its proximity to Monte Carlo. Nice is in fact the chief town on the Riviera, and has the advantages and disadvantages of its position, the latter weighing most with those who are in search of health, and for whom too many social distractions are not to be recommended; the suburbs of Mont Boron and Cimiez are much better in this respect for invalids than the town itself. A beautiful resort in the mountains, about eleven miles from Cannes, is Grasse, a town which has many advantages for those who find the sea coast unsuitable. It has a bracing climate and is fairly well sheltered, but the hotel accommodation is unfortunately rather limited. For quiet people who do not care for social distrac-

tions Hyères, with its suburb Costabelle, has many attractions; it is also one of the oldest of the health resorts on the Riviera. St. Raphael, midway between Hyères and Cannes, and Valescur have been recently much sought after by English visitors; those who wish for absolute quiet and repose will find the latter unequalled, with lovely scenery and beautiful walking excursions on the slopes of the Esterelles. Smaller places, all with good hotels but with no other accommodation, are Antibes, Villefranche, and Beaulieu on the French side, and Alassio on the Italian coast. Bordighera is rather larger and has many attractions; it is more bracing but also more exposed than San Remo. The Riviera di Lavante, which stretches from Genoa to Pisa, is not so well suited to invalids, though very picturesque. Nervi, Rapallo, Santa Margherita, and Spezzia are, however, all frequented by invalids, or at least visitors whose object in travelling is chiefly their health, but the accommodation is not first-class, except at Nervi, and the climate is moister and less sheltered.

Other Mediterranean Resorts

After the Riviera there are a considerable number of health resorts situated on the Mediterranean, of which those in Southern Italy and Sicily have already been briefly mentioned.

Valencia, Barcelona, and Malaga on the Spanish coast have all been recommended, particularly the latter, which has a specially mild climate, approximating to those on the southern shores of the Mediterranean; in none of these towns, however, is there as yet any real provision made for invalids.

Algiers has of late years been largely visited by English people, and in winter usually has a considerable English colony; it has a warm but very uncertain climate, a considerable quantity of rain falling in winter, and occasionally even snow.

Biskra, two days' journey inland from Algiers (one from Constantine), is on the edge of the Sahara, at a height of 360 feet, and is much drier than Algiers, but, like most places near the desert, it is liable to very violent winds, which confine invalids to the house sometimes for several days consecutively.

Tangiers, which is situated in Morocco, between the Atlantic and Mediterranean, has a warm but moist climate, owing to the Atlantic storms touching it. Its civilisation has hardly reached the point at which it can be considered a health resort.

Besides Sicily, some of the smaller islands of the Mediterranean deserve to be considered. Not a few English go to *Malta*, largely owing to its being a garrison town, but it is too windy and devoid of shelter to be considered as a suitable place for invalids.

Ajaccio, in Corsica, is a very attractive place, but the sea voyage from Marseilles in poor steamers is a great bar to many travellers. It is warmer and moister than the Riviera, with a large number of bright, sunny days. The climate is more sedative than that of the Riviera, and therefore suits some invalids better. Those who go there must make their own amusements.

Egypt

Turning to the eastern end of the Mediterranean we come to Egypt, which has since the English occupation become one of the most important places for English invalids, displacing the Riviera to a considerable extent.

Alexandria, on the north coast, has no pretensions to be a health resort, and is a very unattractive town.

Cairo, too, is quite unsuitable for the serious invalid, and should be regarded merely as a halting-place. The town itself is unsanitary, though the hotels are good, and the amount of social life which goes on in winter is far too strong a temptation for invalids.

Mena House, eight miles from Cairo, on the edge of the desert, close to the Pyramids, and Helouan, about fifteen miles distant on an oasis, both have excellent hotels and every accommodation for invalids. The latter is more suitable in the early winter owing to its being raised above the inundated delta; it is therefore much drier during November and December than Mena House. Luxor, on the Nile, 450 miles south of Cairo, has a milder climate and less wind; it is delightful from December to the end of February. It has the drawback of an Arab village, and a large area of irrigated land in the immediate vicinity of the hotel, and more suitable sites could be found in the desert at no great distance. Assouan is at the first cataract and practically on the desert, hence it is drier than Luxor, though both are rainless, rain being unknown in Upper Egypt. It is, owing to the same cause, probably more bracing than Luxor, though distinctly warmer: uncomfortably so after the beginning of March. What effect, if any, the new barrage will have on the climate of Assouan remains to be seen. The question of the journey up the Nile is one of no little importance: the steamers are distinctly dangerous for invalids, especially in returning against the strong north wind, while dahabiehs are costly and slow. Moreover, unless a physician be taken, the invalid on a dahabieh may be far removed from medical aid in the time of need. The question will probably soon be solved by the extension of the train service as far as Assouan, but the river will always retain very great attractions for those whose sole care should be their health. Besides the danger of chill on the river itself, the risks are considerably increased by the temptation to visit numerous places of interest on the voyage: few of them without their dangers for invalids. In truth, this constitutes one of the great draw-

backs of Egypt, for the contrast between sun and shade temperature is very great, and fatigue under the hot sun followed by chill may have disastrous consequences. If the question has not been settled before arrival, an invalid had best take advice in Cairo as to the most suitable means of going up the river.

Egypt owes its reputation chiefly to the desert, of which it is largely composed, and the real problem for the invalid is to make the most of the desert air. The air is extraordinarily pure and very bracing; the rainfall south of Cairo almost nil, and the number of bright, warm, sunny days very great. On the other hand, the winds are often very cold, especially the north wind, which is prevalent during a large part of the winter, and there are not infrequently dust storms or spells of hot wind blowing off the desert, and laden with dust of a very irritating character. The season is from November to March or April, after which it becomes very warm.

On the whole it is one of the best of climates for phthisical patients and other pulmonary sufferers, for chronic renal and cardiac disease, for many rheumatic patients, and for others who need a warm climate which is also bracing.

French Health Resorts

Apart from the Riviera, the only places in France much frequented by English visitors are Pau, Biarritz, and Arcachon, the two latter on the Atlantic coast, the former some little distance inland. Pau is about 600 feet above sea-level, and surrounded, but not shut in, by hills. It is somewhat colder than the Riviera, but rather more equable. There is more rain and less sunshine, and the climate is less exciting, therefore better suited to those of nervous temperament.

Biarritz is a bright, cheerful place, moderately bracing, though the Atlantic brings a good deal of rain at times. It is a good climate for many moderately robust invalids.

Arcachon resembles Bournemouth in being surrounded by pine woods, which are a great protection both against the Atlantic breezes and the winds from the land. It is on a basin connected with the main ocean by a channel; and the climate is rather damp, but free from rapid changes, and sedative.

There are, of course, a large number of health resorts, marine and otherwise, frequented by French people, but few are visited by the English, except such as, possessing baths and springs, come under the section of Balneology. There are probably places in the Pyrenees which would meet many requirements, but they have not as yet been exploited for visitors.

Germany and Austria

What was said about the French health resorts applies very much to those of Germany and Austria, viz., that few except those with baths are frequented by English people. The Black Forest and the Harz Mountains are of course largely visited by tourists, and in Austria Tirol has always a large number of English visitors in summer, some of whom may be invalids.

Meran, however, and in the last few years Innsbruck, both in Tirol, have come somewhat into favour as winter resorts, and a few words should be said about the former. The climate of Meran is, for the most part, sunny, still, dry, and warm. It has an elevation of 1050 feet, and, except to the south, is surrounded by mountains rising up to 10,000 feet, and is therefore well sheltered. The rainfall is small, and there is rarely any fog.

It is frequented chiefly by the robuster class of pulmonary invalids, who do not mind the winter cold.

Great features of Meran are the grape cure, which naturally can only be administered in the autumn, and the whey cure, which is given during the spring.

American Health Resorts

Owing to the great distance, the health resorts of America cannot be said to be much frequented by English visitors, but a considerable number of English people go out for reasons of health in the hope of settling down in some part or other, more especially on the high plateau which forms a large portion of the Western States including Colorado, or in Southern California. The enormous size of the country and the amount of development constantly going on seems to offer prospects of employment, often unfortunately unfulfilled, and tempt many who are unable to live and work in the English climate.

Colorado State takes in a considerable section of the Rocky Mountains, which run through it from north to south. The best part for health is on the eastern side of the Rocky Mountains, which there rise almost abruptly out of the plain, already at an elevation of from 5000 to 6000 feet. From the Mississippi westward there is a gradual but almost imperceptible rise until this great elevation is attained. The rainfall is small owing to the protection of the Rocky Mountains Range on the west; and the climate is therefore very dry, with a large amount of sunshine and particularly bracing qualities. In its effects it resembles that of other high altitudes, such as the Engadine, but is much drier, warmer, and comparatively quite free from snow in winter. In fact, snow rarely lies in Colorado Springs for more than a day or two. This is not wholly an advantage, as the dust is one of the great drawbacks of this region, and owing to the high winds, which are not rare in winter, it is very unpleasant; in fact, the wind and dust are the great drawbacks to the climate.

The atmosphere is exceedingly clear, and the amount of sunshine very large—considerably greater than that in the Swiss resorts. The temperature rarely falls very low, perhaps touching zero two or three times in the winter, and owing to the dryness the cold is little felt unless there be a wind.

The chief health resort is Colorado Springs, about seventy miles from Denver, the capital of the State. It is a bright, cheerful place with a good hotel, but little other accommodation, unless a house be taken. American boarding-houses are not comfortable according to English ideas, and the smaller hotels are, as a rule, unsatisfactory. Rooms can be got in some private houses in the town, but there is not a very large supply of them.

Denver is a town of 150,000 people, the centre of many railways and a busy industrial city. It has an elevation of 5300 feet, or some 700 less than Colorado Springs, though really built on the plain, about 15 miles east of the foothills of the Rocky Mountains. It has about 315 sunny days during the year, and a very large percentage of sunshine. It has, of course, a large number of hotels, some of the first class, and some boarding-houses; and there are naturally greater possibilities of employment in such a large city than in Colorado Springs. It is interesting to note that nearly one-fifth of the population are credited to the class that come for climate and health.

Besides Denver and Colorado Springs there are one or two other places in the same region which may be mentioned. Manitou, about 5 miles from Colorado Springs and nearer the mountains, is more sheltered but gets much less sun. Pueblo, some 30 miles south of Colorado Springs, is a manufacturing city with 35,000 inhabitants, at an elevation of 4700 feet. It has a good winter climate, but is very hot in summer. It is not in itself a very attractive place, and has very little accommodation for invalids.

The summer all over this region is hot, and many people go up into the high mountain valleys or parks, as they are called, at elevations of 8000 to 10,000 feet: the best known of these are Manitou Park, Middle Park, and Estes Park. Some of them have hotels which are only open in summer. As compared with the Swiss resorts, the great advantages of Colorado are the great range of country over which it is possible to move, the greater amount of sunshine, and the greater warmth; the drawbacks are the dust and wind.

The western slope of the Rocky Mountains is much moister than the eastern and much less bracing, but there are many places where an invalid would find a very fair climate. Salt Lake City, with an elevation of over 4000 feet, is an attractive place and a prosperous town, to which a good many invalids resort. In New Mexico and Arizona there are many spots which are well qualified by their elevation, dryness, and sunshine to be health resorts, but they are wholly undeveloped; and Santa Fé, the capital of New Mexico, or Phœnix, in Arizona, would be intolerably dull for a prolonged stay.

Turning to Southern California, we find a very different climate, modified by the presence of the Pacific; it has a very mild winter, a hot but bearable summer, and a considerable amount of sunshine. A large number of invalids go there who are unable to bear the cold of the mountain regions, and sufferers from chronic bronchitis, from heart or kidney troubles, and from irritable nervous systems derive considerable benefit. The chief resorts are Montery, Santa Barbara, and San Diego on the coast, and Riverside, Los Angeles, and Redlands inland. Los Angeles is the capital of Southern California, and has 60,000 inhabitants. Just above it is Pasadena with a very large hotel, filled with invalids in winter. The sea-fogs are at times rather bad on the coast and for some distance inland; the best residence for invalids really is in some of the smaller places on the foothills, but the accommodation outside the recognised resorts is rather rough. A considerable number of English are settled in South California engaged in farming or fruit-growing, but any intending settler is strongly advised to make full inquiries before embarking on such projects.

Florida, like Madeira, has lost most of its reputation as a resort for consumptives owing to the distinctly enervating character of its air and the fact that malaria is not uncommon, but it still attracts a large number of visitors and semi-invalids in winter, and has very good hotels.

British Columbia has a climate with many advantages for invalids — bright, clear, dry, bracing, yet not cold; but, with the exception of Kamloops, 1100 feet, and Calgary, in Alberta Province, 3500 feet, it has no provision for visitors. It is a much less rigorous climate than that of the North-West United States.

South Africa

Now that South Africa has become an exclusively British possession, and the tide of emigration seems likely to set in strongly towards it, there can be little doubt that the many possibilities which it offers to the health-seeker will have more attention paid to them than heretofore. The days are long past when Cape Colony was regarded as one of the sanatoria of India, before the Suez Canal was opened; but its climate nevertheless is delightful in summer, *i.e.* during the northern winter, the heat never being excessive, whilst there is a large amount of sunlight with a clear sky and dry atmosphere. The chief rainfall is in May, June, and July. Cape Town is not itself

a desirable place for invalids, but Wynberg and Sea Point are both very good.

But it is the climate of the high upland plateau, known as the Karroo, which is specially beneficial to invalids, and here there are many places which in the future should become important sanatoria, and already have considerable reputation. One of the first to be reached is Matjesfontein, at an elevation of 3588 feet and about 200 miles from Cape Town. The climate is very dry and bracing, with a rainfall of only 5·5 inches, and almost perpetual sunshine. These qualities are characteristic of the Great Karroo, which has an average elevation of 3000 feet, but with mountains rising up to 7000 feet. The summer heat is considerable, but is easily borne owing to the fine air, while the nights are always cool. Beaufort West and Graaff Reinet are both good spots in this district.

In the eastern provinces Grahamstown, 1750 feet, Craddock, 2856 feet, and Tarkasted, 4280 feet, are all beneficial to different classes of cases.

Queenstown, Molteno, near the Stormberg Range, 3544 feet, and Burghersdorp, 4550 feet, 30 miles north, are both attractive places with fine climates.

Aliwal North, 4330 feet above the Orange River, is well known, not only on account of its climate, but for its mineral springs. A considerable number of pulmonary cases have in the past derived great benefit here from the pure air.

In Natal a delightful climate, somewhat moister than that of the Karroo, but invigorating, is found; and the capital, Pietermaritzburg, 2225 feet, is a good resort for sufferers from bronchial troubles. Howick, 3500 feet, Estcourt, 3800 feet, and the well-known Ladysmith, 3280 feet, all enjoy good climates.

The Orange Free State consists largely of country resembling the Karroo, but considerably higher. The climate is very similar, and the dust is one of the chief drawbacks here as elsewhere. Bloemfontein, the capital, 4518 feet, has long been a resort for phthisical patients, and many have recovered their health here. Bethlehem and Harrismith, both over 5000 feet, have good mountain climates, and the latter is much visited by invalids from Natal.

The Transvaal has many spots which might be utilised for invalids and have considerable elevation, but they are not laid out to attract invalids; and Johannesburg has a somewhat dangerous climate, marked by rapid changes, and its sanitary conditions are bad.

There are many other places in South Africa besides those mentioned which might be visited by invalids, but enough has been said to show the great climatic advantages which it offers.

Australia and New Zealand

Though generally classed together, there is no similarity whatever between the climates of these countries, and separated as they are by 1000 miles of sea it is more a matter of custom and convenience than anything else which causes their conjunction.

Taking Australia first, it must be said that the coast towns (and all the principal towns lie on the coast) are singularly unfitted for invalids owing to their moist atmosphere and liability to sudden change. The best of them, perhaps, is Adelaide, the capital of South Australia, which has a moderately dry climate, but is liable to great heat. It must be remembered that neither here nor in New Zealand are there any organised health resorts, and there is no provision for invalids or even comfortable accommodation outside the big towns, which we have just said are unsuitable. The up-country towns are for the most part very small places, with probably one or two third-class hotels, very little amusement, and scant society. It may be gathered, therefore, that the number of invalids for whom Australia is suited is very small, save those who come to settle.

The climate of the Riverina and Darling Downs is excellent: warm, dry and bracing, with moderate elevation, it is admirably suited for the phthisical patient, or for sufferers from renal or cardiac trouble, who need a warm yet bracing winter, and the same applies to much of the large inland plateau.

At Orange in New South Wales, 2400 feet, a Government Sanatorium has been established, and this place seems likely to develop. Other towns where moderate accommodation can be found, all on the high inland plateau, but far apart, are Bathurst, Bourke, Deniliquin, Hay, and Tamworth.

New Zealand.—The climate of New Zealand is very much like that of England, but warmer and less humid; there is a fairly heavy rainfall, but much less fog and mist and more sunshine.

The same caution as in Australia must be given with reference to accommodation for invalids, which is almost wholly wanting. The country has many advantages for those who propose to settle, but few for visitors, unless they are in robust health and capable of long coach journeys.

The two extreme ends of the island are unsuited for invalids, the one being semi-tropical, and the other having a climate somewhat resembling the Scotch lowlands.

But there is a considerable area in the provinces of Canterbury and Nelson in the south island, and of Wellington and Napier in the north, which offers very pleasant and healthy settling ground for English emigrants. The towns of the same provinces all have good climates; Christchurch is the best in some ways, but it is hot in summer. Wellington is more bracing, but very windy. Napier and Nelson are both equable climates and fairly bracing in winter.

None of New Zealand is very bracing, unless a considerable elevation be reached, as on the slopes of the Southern Alps, the eastern side of which is very pleasant, the west being very rainy.

In short, the climate is a very pleasant one to live in, and seems to suit the Anglo-Saxon race very well, as it admits of a large amount of open-air life, and the atmosphere is remarkably clear and bright; but it has not in most places the stimulating properties which tuberculous patients desiderate, and the country does not lay itself out to attract the travelling invalid.

The Islands of the South Atlantic

These comprise Madeira, the Canaries, Teneriffe, and Grand Canary, which all of course belong to the marine group. Madeira was in great vogue thirty or forty years ago, but has now been almost abandoned, so far as cases of consumption go. It is decidedly moist and somewhat relaxing, with a tendency to depress people after any prolonged stay and to produce digestive troubles and diarrhœa. It is, however, in Sir H. Weber's opinion, well suited for elderly people with much loss of lung and emphysema, especially when complicated with albuminuria, and it is well adapted for sufferers from chronic bronchitis.

The other islands mentioned are situated some degrees south of Madeira and therefore decidedly warmer, but they are drier, and on Teneriffe there is a possibility of attaining some degree of elevation and therefore more bracing effects.

There is good accommodation to be got both in the Canaries and Madeira, but means of amusement are rather lacking, though the scenery is very beautiful and the vegetation luxuriant.

Therapeutics: Serum Therapy.

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An attempt will be made within the compass of a short article to give an account of the principles and practice of serum therapy.

In the first place, it is necessary to have some idea of what is meant by "immunity." It is the converse of predisposition. Some people exhibit a tendency to contract certain diseases, whilst others are proof against them. The immunity may be natural or it may be acquired. In some instances it is purely physical, as when toxic substances taken by the mouth are not absorbed by the mucous membrane of the alimentary canal, but pass out unchanged. Natural immunity may be personal or it may be racial; it may be temporary or it may be permanent. The most familiar example of acquired immunity is the unsusceptibility to a second attack of a person who has passed through certain diseases. It is well known that many infectious diseases confer on those who have suffered from them a power of resistance against subsequent attacks. Soon after the discovery of the microbian origin of infectious diseases, it was shown experimentally that if the microbe constituting the cause of the disease were inoculated into animals it would not only produce the symptoms of the disease, but would impart to the animal the power of resisting the morbific influence of the same microbe when subsequently inoculated. It was also found that the protection could be induced by the filtered and therefore microbe-free solution in which the pathogenic microbes had been cultivated, a conclusive proof that neither the original disease nor the artificial production was due to the microbe, but to the toxic substance produced by it. Later on it was shown that the blood-serum of protected animals, although destitute of toxic properties, when introduced into non-protected animals conferred on them a resisting power so great that even lethal doses of the virulent micro-organism or its toxin produced no effect. This is the basis of serum therapeutics, and the most marked results are those obtained by injecting substances derived from the blood of protected animals into the circulation of those not protected.

The preparation of an immunising substance is attended with much difficulty, and a potent antitoxin may take many months to prepare, the process involving technical difficulties which can be overcome only by those thoroughly conversant with the subject. The toxin is usually obtained by growing the bacilli in a flask containing nutrient broth, to which ½ per cent chloride of sodium and 2 per cent peptone have been added. The fluid freed from micro-organisms is injected. A small dose produces no dangerous symptoms, but suffices to ensure the formation of sufficient antitoxin to neutralise the poison. After a time a second and larger dose of toxin is injected. This is partly neutralised by the toxin already formed, and the surplus stimulates the production of more antitoxin. The process is carried on cautiously until there is enough antitoxin in the circulating serum to render harmless what would otherwise be a bitter dose of the poison. The animal is then "immune," and the immunising serum from the animal is injected into a patient as a therapeutical agent.

The curative value of a serum is in direct relation to its protective power, and to obtain

an active serum the animal must be endowed with the highest degree of immunity. To procure a serum of this description horses are employed, which may be inoculated either with gradually increasing doses of the toxin or of living or dead bacteria. This must be done slowly and cautiously, but by following out this principle a serum of maximum intensity is obtained.

Each antitoxin affords protection only against the particular disease to which it is antagonistic. For example, the antitoxin of diphtheria affords no protection against tetanus. Each infection requires for its prevention or cure a specific antitoxin. Probably the only exception to this is in the case of snake-bite, for a serum can be obtained which is so highly antitoxic against the venom of one snake that it will counteract the poison of a snake of a different species.

The serum is usually injected into the anterior wall of the abdomen, but any part where the skin is loose will serve. It is better not to inject into the back or buttocks from the risk of bed-sores. The skin should be rendered aseptic by washing it first with soap and turpentine, and then with absolute alcohol or with dilute carbolic acid. When the bulk of the fluid exceeds 25 c.c., more than one injection will have to be made. Absorption soon takes place, and manipulation of the part is quite unnecessary. A special syringe must be employed, and it should take to pieces so that it may be readily boiled in a test-tube. The most convenient capacity is from 10 to 20 c.c., but the 25 c.c. is useful. There is no particular advantage in having the glass barrel or piston graduated. The platinum and iridium needles can be sterilised in a spirit flame. The syringes are supplied by most makers of serums, and cost about 12s. 6d.

Serum treatment is employed in diphtheria, in the pyogenic diseases, such as erysipelas and puerperal fever, in tetanus, glanders, anthrax, and snake-bite. There are indications that before long its scope of action will be extended to other diseases. The records of well-observed cases of necessity accumulate somewhat slowly, and it is necessary to rest on well-established ground before taking a new departure. There is reason to think that simple physiological serum may have some value as a curative agent, and of late horse serum has been employed tentatively. Horses are not prone to tubercle, and it is possible that ultimately advantage may be taken of this fact. Horse serum is supplied for test by several makers.

Antidiphtheritic Serum. — The most notable success of serum therapeutics is in connection with diphtheria. Introduced originally by Behring in 1890, and elaborated by Roux of Paris, it has been universally adopted. Aronson was the first to utilise horses in the preparation of the serum. Statistics have accumulated to an enormous extent, and without exception show a marked diminution in the mortality from the disease under the serum treatment.

There are many brands of antidiphtheritic serum, varying much in the number of units they contain. The serum is now always prescribed according to the number of units, irrespective of the dose of the injection. The antitoxin unit is the amount of antitoxin which, injected into a guinea-pig of 250 grammes in weight, neutralises 100 times the minimum fatal dose of toxin of standard strength. This is known as the Behring unit. The Ehrlich unit is somewhat different, the test dose being that which, when mixed with a unit of serum, just suffices to kill the animal in four days. Roux's constant is a toxic solution, of which 0·1 c.c. kills a guinea-pig weighing 500 grammes in twenty-four hours. These standards are arbitrary and conventional, but they are convenient. The mode of manufacture of these serums is, under expert guidance, being constantly improved, and in most cases the maker's guarantee as to strength, purity, and dose has to be accepted. Many of these products, however, are under some form of central control. In Germany all forms of serum permitted to be sold are subject to constant official examination. The bottles are filled under supervision, and to each is attached a lead seal, on which is stamped the number of immunising units. This plan is followed by one firm in England, every batch of antidiphtheritic serum being tested by the Superintendent of the Laboratories of the Royal College of Physicians of London and the Royal College of Surgeons of England, under whose supervision the bulbs are filled. It may be that the guarantee is not greater than that afforded by the experts attached to other firms, but it is an additional security.

The antidiphtheritic serums in common use in this country are those prepared by (1) The Jenner (formerly the British) Institute of Preventive Medicine, (2) Burroughs Wellcome and Co., (3) Parke, Davis and Co., (4) E. Merck (Darmstadt), (5) Behring (Fabrik: Hochst-Am-Main), (6) Aronson (Berlin: Schering's Fabrik), and (7) Roux (Institut Pasteur, Paris). The preparations used in the United States are those of: (1) The New York Board of Health, (2) Parke, Davis and Co., (3) Burroughs Wellcome and Co., (4) Mulford and Co. of Philadelphia, (5) Gibier of New York, (6) Behring, (7) Aronson, and (8) Roux.

Many of these preparations are sent out in several different forms.

The Jenner Institute (Chelsea Gardens, Grosvenor Road, London; agents, Allen and Hanbury) offers the serum in vials containing 2000 units, supplied in cases holding two vials, at 5s. the case. Burroughs Wellcome and Co. (Snow Hill Buildings, London, E.C.) supply their serum in hermetically sealed tubes con-

taining (1) one prophylactic dose of 1000 units at 1s. 3d.; (2) one therapeutic dose of 2000 units at 2s. 6d.; and (3) one therapeutic dose of 4000 units in 5 c.c. or less at 7s. 6d. Parke, Davis and Co. (111 Queen Victoria St., London, E.C.) offer two grades of serum differing in their potency. For an early case No. 4 of the X or Standard, containing 2000 units at 3s. 2d., may suffice, but it would be better to use the XX or Special at 6s. 2d. For an advanced case two doses of No. 6 XX Special, containing 4000 units, would be necessary, and this costs 9s. 6d. a dose. For very severe cases two doses of No. 8 Special, containing 6000 units in each, at 15s. the dose, would be required. E. Merck of Darmstadt supplies "500-fold" serum in doses of 600, 1500, and 3000 units, and also sends out "1000-fold" serum. Behring's serum is comparatively little used in England, but in the United States the higher grades, Nos. 4, 5, 6, and 7, containing respectively 200, 300, 400, and 500 units in each c.c., are employed. Aronson's serum has ceased to be popular, whilst that of Roux is said to be no longer prepared under his personal supervision.

The more potent the serum and the greater the number of antitoxin units contained in a c.c. the better is it adapted for practical purposes. When from 8000 to 12,000 units have to be given, the bulk of the injection is a matter of considerable moment, especially in the case of children, who do not take to frequent or multiple injections kindly.

These serums, if kept in a cool place and away from the light, will remain active for a year, but there is always some decadency of potency, and the higher the grade the greater the deterioration. Some makers add an additional number of units to their phials to counteract this tendency. A phial once opened must be used immediately: the portion unused is useless.

Dried antidiphtheritic serum is sold by some makers, and the Jenner Institute supplies it in tubes containing 300 units, at 60s. the dozen tubes. It is said to be useful for export, but as the ordinary tubes bear carriage well there seems to be no particular advantage in its employment. In dissolving the scales, from 2 to 3 c.c. of water, which has been boiled and allowed to cool, should be poured into each tube. Care must be taken by shaking and rotating the tube to prevent the scales from caking.

The question of dose is very important, and a good deal depends on the stage of the disease in which the patient is first seen. If the treatment is commenced on the first day 2000 units will suffice, but if delayed until the second day from 8000 to 12,000 units will be necessary. Putting it in another form, for a mild, that is an early case, in which the exudation is limited and there are no constitutional symptoms, 2000 units is the dose, whilst for more severe cases, those usually seen on the second day, from 8000 to 12,000 units will be required, the exact dose depending on the extent of the exudation and the gravity of the constitutional symptoms. The injection will have to be repeated within twenty-four, and probably within twelve hours, but if the patient show signs of decided improvement only one-half of the initial dose need be given. As a prophylactic 600 units will suffice. The serum treatment should invariably be resorted to in children, and practically in every case, the only possible exception being in very mild cases in adults. Time is of the utmost importance, and not a moment should be lost. On the first day a dose of 2000 units will secure a result which 50,000 will not effect on the third or fourth. It is useless to wait for the result of a bacteriological examination, for that involves loss of valuable time, and it is well known that there are many cases which are clinically diphtheria, but which bacteriologists decline to recognise as such. The serum has no toxic action, and it is better to give too much than too little. In severe cases the patient must be brought rapidly under the action of the drug. This is especially the case when there is bronchopneumonia as a complication, for then the lungs always contain bacilli in large numbers.

Although the general consensus of opinion is in favour of large doses, Professor John H. Musser of Philadelphia claims that he has obtained good results from small and frequently repeated doses, especially in children. For children under eight he gives 500 units, repeated every six hours, whilst for children over eight he gives 1000 units, and repeats it at intervals of from six to eight hours.

Toxic effects sometimes follow the injection of the serum, but they are rarely of importance. They commonly assume the form of a rash, which may be urticarial or erythematous. Sometimes it is scarlatiniform, or it may be like the rash of measles. The urticaria may attack not only the skin but the mucous membranes, giving rise to vomiting and diarrhœa, and even urethritis. As there is usually some pain in the joints with elevation of temperature, there may be a difficulty in diagnosis. The antitoxin rash usually appears on the eighth day, is seldom seen before the sixth day, and rarely appears after the eighteenth. The occurrence of the rash bears no relation to the amount of antitoxin injected. The serum itself is not toxic, and these untoward symptoms are due to impurities. It is said that with some serums there is never any rash. In one instance in the United States a batch of antidiphtheritic serum in the process of manufacture became contaminated with tetanus bacillus with disastrous consequences.

The administration of the serum does not contraindicate the use of local measures, and

every effort should be made by spraying, irrigation, and swabbing to remove exudation. The use of the serum will not prevent the occurrence of post-diphtheritic paralysis. There is no evidence that the serum produces nephritis.

Antistreptococcus Serum.—The first attempt to cure streptococcic infection by the use of serum was made by Marmoreck in 1895. The serum is now used in erysipelas, cellulitis, general suppurative peritonitis, suppurative disease of the middle ear, thrombosis of the lateral sinus, and puerperal septicæmia. In malignant endocarditis it sometimes answers well, but not uncommonly fails. The organism associated with this disease may be a streptococcus or it may be a staphylococcus. If the disease is due to streptococci the antistreptococcus serum proves efficacious, but if it is due to staphylococcal infection it is useless. The nature of the infection is usually difficult to determine, so that the results are uncertain. Marmoreck's claim that his serum will cure all streptococcic puerperal infections appears not to be substantiated. The serum is of great value in certain cases, but in others apparently identical it has been found useless. This is attributable to their causation by different varieties of streptococci. Should a particular serum fail, it would be well to try a serum from another source. It is now recognised that a serum obtained from a given streptococcus may protect an animal from that organism, but be absolutely inefficient against another streptococcus. It is clear that the number of serums which can be prepared is limited only by the varieties of streptococci which exist.

The results obtained in erysipelas and other streptococcal infections are often so strikingly successful that the serum should be used in every case, especially as its administration does not preclude local treatment or even the administration of drugs such as perchloride of iron by mouth. Antistreptococcic serum is supplied by the Jenner Institute; Parke, Davis and Co., and other makers, but whether their products are identical it is impossible to say. It is best to inject three doses of 10 c.c. at intervals of six hours, with of course the usual antiseptic precautions. The case containing the three 10 c.c. vials costs from 7s. 6d. to 12s. Burroughs Wellcome supplies both an antistreptococcus and an antistaphylococcus serum in 10 c.c. phials. These serums have no toxic action, and 30, 35, and even 75 c.c. have been given as a dose. In a severe case of erysipelas it would be justifiable to begin with 20 c.c. of the antistreptococcus serum,

Antitetanic Serum.—The treatment of tetanus by antitoxin was introduced by Behring and Kitasato in 1890. Tetanus was the disease in which investigation led to results which paved the way for the more important serum treatment of diphtheria. It was selected for the purpose of experimentation from the certainty with which definite results could be obtained in animals submitted to observation, and yet, strangely enough, of all the serums in common use the antitetanic gives the most unsatisfactory results. The antitetanic serum commonly employed is that of Tizzoni and Cattani. It is in the form of dry scales, and is supplied in vials containing $4\frac{1}{2}$ grammes, or sufficient for an ordinary adult case, at 45s. the vial. The best plan is to inject 2·25 grammes at the first dose, and 0·6 grammes for subsequent doses. The scales may be dissolved in distilled water, normal saline solution or blood serum. The Jenner Institute supplies the serum in cases holding three tubes of 10 c.c. each, at 12s. the case. They also supply a dried serum in tubes containing 3 grammes, at 12s. a tube. Burroughs Wellcome and Co. supply the serum in phials containing 10 c.c. at 3s. 4d. each. The dose employed should be large, to the extent even of 100 c.c. of the serum, so that the treatment must of necessity be expensive. The direct strength of a tetanus toxin is measured by the body weight in grammes of an animal which is killed with certainty by 1 gramme of the toxin. The indirect strength of a toxin is its antitoxin neutralising power. In some cases of tetanus in man very large doses have been given; for example, Wilms records the case of a patient who within thirty hours received 4,000,000 Tizzoni units, followed on the second, third, fourth, and fifth days by 1,000,000 units each day. There seems to be no particular advantage in intracranial injections.

The serum gives the best results in chronic cases. It not infrequently happens that the bacillus is localised and confined to the seat of infection, so that free excision with the application of pure carbolic acid should be resorted to in addition to the use of the antitoxin. Horses, as is well known, are especially liable to tetanus, and in them the antitetanic serum answers well. By systematic immunisation with the serum the death-rate amongst them from this disease has been materially reduced. A veterinary antitetanus serum is supplied by Parke, Davis and Co. at 4s. the oz.

The immunity to tetanus in man conferred by the serum is temporary, and is probably limited to six or eight weeks. The antitoxin is excreted by kidneys, mammary, and other glands.

Antivenene.—For our knowledge of the treatment of snake-bite by this substance we are indebted chiefly to the researches of Sir Thomas Fraser of Edinburgh and Dr. A. Calmette of Lille. Venomous snakes may be divided into two categories:—(A) Poisonous colubrine snakes; (B) viperine snakes. In class (A) are included the cobras, the kraits, the coral snakes, the moccasins, the tiger snake, the black snake, and the deaf adder. In class (B) are the English viper, the rattlesnake, the *Daboiá Russellii* of

India, and the *Echis carinata*. Although these poisons have different physiological actions, the same antidote is used for all. The dose of serum required to protect a man against a lethal dose of the most deadly venom is from 10 to 20 c.c., but additional security would be afforded by injecting 30 or 40 c.c. No ill effects attend the injection of the serum, which acts most surely and quickly when injected intravenously. The more speedily the injection is made the greater the patient's chance of recovery. There should be no relaxation in the mode of treatment ordinarily adopted, and ligatures and local treatment should be employed. Antivenene is now distributed largely in India, and specimens returned after a year showed no falling off in activity. The charge made by the Jenner Institute for 10 c.c. tubes is 50s. a dozen.

Coley's Fluid.—This fluid is named after Dr. William B. Coley of New York. It is a mixture of the streptococcus of erysipelas with *bacillus prodigiosus*, a non-pathogenic organism which is supposed to possess the property of intensifying the action of certain pathogenic germs. The two organisms are grown together in the same broth, the erysipelas streptococcus being first grown alone for ten days, when the other germ is added and the cultivation continued for another ten days. The cultures are heated to a temperature sufficient to render them sterile, and the fluid is then used without filtration. This preparation is much stronger in its action on malignant tumours than the filtered solution. The best plan is to begin with a small injection, $\frac{1}{2}$ to 1 minim, and to gradually increase it daily until the reaction temperature reaches 103° or 104° F. The temperature is the best guide in estimating the dose, and very little benefit accrues in cases in which no reaction occurs. The frequency of the injections will depend on the general condition of the patient, and on the rapidity of recovery from the depression of the preceding dose. Usually the injections are administered daily, an endeavour being made to get two or three good reactions a week. The most virulent cultures give the best results. The treatment should be continued for three weeks, and if at the end of that time there is no improvement it should be abandoned. In some cases, however, it has been continued for three months, with from time to time an interval of a few days. The serum may be injected either subcutaneously, or into the substance of the tumour, but the former method is preferable. The usual precautions are taken in administering the injection: the skin is rendered aseptic, and the needle is sterilised by being passed through a spirit flame. The chief dangers are from collapse from too large a dose of the toxins being injected into a vascular growth, and from pyæmia, due to insufficient precautions as regards asepsis, especially in cases where there is a granulating or sloughing surface. With the observance of strict aseptic precautions, however, the risk is small.

The mixed toxins may be used in any form of malignant tumour which is clearly inoperable. It may also be employed after primary operation to prevent recurrence. The beneficial effect is slight in most cases of carcinoma, including epithelioma, and it is most marked in sarcoma, but varies with different types; the spindle-celled form being the most favourable for treatment.

Most of these statements are given on the authority of Coley's papers, and many of them require confirmation. Prof. Robert B. Wild of Manchester treated eight cases of inoperable cancer by this method. The patients were kept under observation until death, and in six of them the diagnosis was confirmed by autopsy. Dr. Wild thinks that in cases of inoperable carcinoma and epithelioma there is no evidence of permanent benefit, but that in the absence of other means of effectual treatment a trial of the serum is justified in cases of inoperable sarcoma, especially the more rapidly growing forms.

Coley's fluid is supplied by the Jenner Institute in tubes of 2 c.c. at 5s., and by Parke, Davis and Co. in ounce vials at 12s.

Mallein.—Glanders, farcy, or mallein is a disease due to the presence of the *bacillus mallei*, a short, non-mobile bacillus, not unlike that of tubercle, but exhibiting different staining reactions. The toxins which are produced in cultures of this bacillus have been separated, and in concentration as a glycerine extract are known as mallein. It is used diagnostically in horses supposed to be suffering from glanders, to detect the presence of the disease. When injected in a dose of 1 c.c. into a glandered horse, the temperature rises from 2° to 4°, whilst in a horse free from glanders no reaction is obtained even after a dose of 6 c.c. It is also employed for conferring immunity on horses, and for curing them of the developed disease. Mallein is of little use in the acute farcy of man, which is an almost uniformly fatal disease, but in chronic cases it is useful. The continued injection of $\frac{1}{20}$ to $\frac{1}{15}$ c.c. at intervals of two days is usually followed by improvement. Mallein can hardly be regarded as a commercial article, but it is supplied by Parke, Davies and Co. at 2s. 6d. the c.c., the dose required for diagnostic purposes in horses.

Tuberculin.—Whether in an article on serum therapeutics this substance should be included is open to question. Koch's original tuberculin is now very rarely used therapeutically. For diagnostic purposes both in man and in cattle it answers admirably. A patient may be suffering from tuberculous peritonitis, and yet the symptoms and physical signs may be so obscure as to leave the diagnosis in doubt. A bottle of the original tuberculin is procured, and 1 c.c. is diluted with 9 c.c. of 0·5 per cent phenol to make a 10 per cent solution; of this 1 c.c.

is diluted with 9 c.c. of the phenol to make a 1 per cent solution. Of this dilution 10 minims are administered subcutaneously with the usual precautions. If the patient is not tuberculous there is no rise in temperature, but if tubercle is present it will run up to 102° or 103°, and fall again in twenty-four hours. There will probably be considerable constitutional disturbance, indicated by restlessness, headache, pains in the joints, and inability to sleep.

The preparation commonly employed in the treatment of phthisis is tuberculin R. The best plan is to begin with a dose of $\frac{1}{500}$ mg., and to run up to 20 mg. The larger doses are expensive,—about 17s. a dose,—and from 50 to 60 injections may be required, although not all of this magnitude. Good results have sometimes been obtained, but usually in conjunction with favourable hygienic conditions, and the administration of cod-liver oil and other remedies. It appears to be of very little use in mixed infections or in advanced cases. In a few cases carefully observed at the Westminster Hospital it did no good, and its use had to be abandoned. It produces a very slight reaction even in moderately large doses. Tuberculin, as a diagnostic agent, is invaluable, but therapeutically it leaves much to be desired.

Maraglioni's serum is frequently spoken of in connection with the treatment of tuberculosis, but it is difficult to obtain definite information respecting its action. Campana of Rome states that it is nothing but Koch's tuberculin improved. Rumpf of Hamburg maintains that it has no therapeutical effect, whilst Bertola says that it has a specific action in tuberculosis, but that it must be administered for a long time. It has been but little used in England.

Antienteric Serum. — This can hardly be regarded as a therapeutic agent, although it is a powerful prophylactic. The results obtained by the inoculation of the serum in the case of the officers and men of the military garrison during the siege of Ladysmith, as published by Prof. A. E. Wright of Netley, are distinctly encouraging, inasmuch as they show that the proportion, on the one hand of attacks and on the other of deaths, was seven times less in the inoculated than in the uninoculated. If the number of men, no doubt a considerable one, who had previously suffered from enteric had been subtracted from the number of the uninoculated, the statistics would have borne an even more favourable aspect.

Antipneumococcic Serum.—Several serums of this description have been prepared by Pio-Foa, Washbourn, and others, but they are rarely used.

Therapeutic Test.—The diagnosis of a disease by administering a remedy which has a specific effect (*e.g.* quinine in malaria, mercury in syphilis), and judging from the result; thus, in obscure eye conditions or nervous maladies, improvement under mercurial treatment suggests syphilis as the causal factor.

Theriaca.—An old name for a compound containing several drugs, and supposed to have the effect of an antidote in the bites of poisonous animals (Gr. *θηρίον*, a wild beast); as treacle was used in the compounding of the antidote the name theriaca came to signify molasses or treacle.

Theriatrica.—Veterinary medicine.

Therma.—A warm spring or bath. *See* Balneology (*Historical*).

Thermæsthesiometer.—An instrument for determining cutaneous sensibility to heat in different regions of the body.

Thermal.—Belonging to heat (Gr. *θέρμη*, heat); e.g. *thermal analgesia* (cutaneous anæsthesia to thermal impressions, as in syringomyelia, *q.v.*), *thermal springs* (springs producing warm water, usually containing a medicinal agent), etc.

Thermic.—Relating to heat, e.g. *thermic fever*. *See* Sunstroke (*Nomenclature*); Tropics, Unclassed Fevers of the (*Continued Fevers of Short Duration*).

Thermo-.—In compound words *thermo-* (Gr. *θέρμη*, heat) means relating to or produced by heat; e.g. *thermo-anæsthesia* (loss of perception of heat, *see* Hysteria), *thermochroic* (transmitting some thermal radiations but not others, which are changed or absorbed), *thermotherapy* (treatment of disease by heat), etc.

Thermocautery. *See* Cautery (*Paquelin's*).

Thermogen.—A special appliance for keeping up the temperature of a patient during a lengthy operation.

Thermogenesis. — Heat production. *See* Antipyretics and Antipyretic Measures; Physiology, Fate of Food Absorbed (*Production and Elimination of Heat, Temperature*); Temperature (*Normal, Variations, etc.*).

Thermohyperæsthesia. — Abnormal sensitivenesss to heat (Gr. *θέρμη*, heat; *ὑπέρ*, over; and *αἴσθησις*, sensation).

Thermol.—A coal-tar product, acting, in doses of 3 grains, as an antipyretic, analgesic, and antiseptic; its formula is $C_{14}H_{15}NO_3$.

Thermolysis.—The dissipation of heat, *e.g.* by the skin and lungs; also chemical decomposition produced by heat. *See* Antipyretics (*Modes of Action*).

Thermometer. *See* Meteorology; Temperature; etc.

Thermopylæ. *See* Balneology (*Greece*).

Thermotaxis.—The regulation of the body heat. *See* Antipyretics and Antipyretic Measures (*Modes of Action*).

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